

HOUSE

No. 2169

SPECIAL REPORT

OF THE

MERRIMAC VALLEY WATERWAY BOARD

RELATIVE TO THE

DEVELOPMENT OF NAVIGATION AND POWER IN
AND ALONG THE MERRIMAC RIVER

UNDER AUTHORITY OF

CHAPTER 708, ACTS OF 1912, AND CHAPTER 59, RESOLVES OF 1913.

JANUARY, 1914.

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The Commonwealth of Massachusetts.

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts.

The Merrimac Valley Waterway Board, appointed under the provisions of chapter 708 of the Acts of 1912, respectfully submits its second and final report concerning an investigation of the Merrimac River, in accordance with the provisions of that act, and of chapter 59 of the Resolves of 1913, extending the time for filing said report to the second Wednesday of January, 1914, and the term of office of the Board to Feb. 1, 1914.

Chapter 708 of the Acts of 1912 is as follows: —

SECTION 1. Upon the passage of this act the governor, with the advice and consent of the council, shall appoint a board to consist of three citizens of the commonwealth, one of whom shall be a member of the board of harbor and land commissioners. The governor shall designate the chairman of the board, which shall be known as the Merrimac Valley Waterway Board. The board shall receive such compensation as the governor and council may determine. The term of office of said board shall expire upon the making of the report hereinafter provided for.

SECTION 2. It shall be the duty of said board to make a thorough survey and study of the possibilities of development of navigation and power in and along the Merrimac river, and, in so doing, to employ competent engineers and assistants and by personal inspection and by discussion with the people in the various cities and towns along the Merrimac valley to ascertain the facts and to learn the desires of the people along said river. The board shall hold meetings in the various cities and towns in said valley in regard to the development of the Merrimac river for navigation and power, shall make a thorough and comprehensive plan for such development, and shall make a report to the general court on or before the first day of February, nineteen hundred and thirteen, and accompanied by said plan and by such recommendations for legislation as the board may determine.

SECTION 3. To meet the expense of said investigation and report, the sum of ten thousand dollars may be paid out of the treasury of the commonwealth.

SECTION 4. This act shall take effect upon its passage. [Approved June 4, 1912.]

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This act comprehends: —

Survey and study of possibilities of development of navigation in and along the river.

Survey and study of possibilities of development of power in and along the river.

Personal inspection and discussion with people in the various cities and towns along the Merrimac valley to ascertain facts and learn the desires of the people along the river.

Public hearings.

Plans for development of river for navigation and power.

A preliminary report dated Jan. 28, 1913, was made to the Legislature, printed in House Document No. 1824 of 1913, and considered by the legislative committee on harbors and public lands. Up to that time the Board, which held its first meeting Aug. 23, 1912, had given public hearings at Newburyport, Haverhill, Lawrence, Lowell and Amesbury; made inspections of the river from Lowell to the sea; conferred with the district engineer officer in charge of river and harbor works in the territory including this river; ascertained, both by personal interviews and by correspondence, facts and general information concerning the desires of the public, the developed water power, the character and amount of business carried on in the several cities and towns along the river, and collected statistical matter in as complete form as possible. Furthermore, for the purpose of studying present river conditions, including depths of water, obstructions to navigation, number and location of bridges, and other data, a map of the whole length of the river in Massachusetts was prepared from surveys and maps by the federal government and by the State of Massachusetts, and from other sources. A survey had also been commenced of the territory at and near the dam at Lawrence, which is described later in this report.

It was stated in the preliminary report that the term of office of this Board should be extended for the purpose of making further surveys and examinations and continuing work then in progress, "In order that there may be no delay on the part of the State and the various municipalities in carrying out such work, supplementary to that of the government, as will provide the facilities necessary to carry on the large amount of business

which will surely follow the opening to navigation of the whole river.”

A very important consideration in connection with this investigation was the fact that the river and harbor act of Congress, approved July 25, 1912, provided for a preliminary examination of the Merrimac River, “with a view to securing increased depth from Lowell to the sea or in any part of this section of the river.” When entering upon its studies of the problem involved, the Board found that inquiry covering substantially the same matters included in the legislation of 1912 aforesaid, as well as others in addition, was contemplated by the United States engineer officer stationed at Boston, in compliance with his instructions. Consequently, conferences were held, and a plan of co-operative procedure discussed and adopted for the purpose of avoiding duplication of work and procuring all possible information and data to enable that officer, as well as this Board, to prepare full and comprehensive reports. In pursuance thereof copies of the stenographic reports of public hearings held by this Board; and of statistical and other information collected were furnished the district officer, and have been used and quoted at length in his report. The Board has also been greatly aided in its work by the receipt of facts and figures in the possession of that officer.

Early in March, 1913, this Board directed its engineer to make an examination and survey of that part of the river from Ward Hill to the pool above the Lawrence dam: —

(1) For the purpose of preparing plans and estimates of the cost of an adequate channel.

(2) For the purpose of preparing plans and estimates of cost for building a canal, with suitable locks, on the upland along and near the south bank of the river, connecting the pool above the Lawrence dam with the channel of the river, just below Ward Hill. Statement, in detail, relating to this and other surveys, is made on subsequent pages of this report.

Up to April 1, 1913, there were nine regular meetings of the Board, in addition to the public hearings and conferences previously mentioned, at which many matters relating to the subjects under investigation were considered. Later in this month application was made to the chief of engineers, U. S. A.,

for a copy of the report of Col. Frederic V. Abbot, Corps of Engineers, U. S. A., dated March 29, 1913, on his preliminary examination of this river, required by the river and harbor act aforesaid, and the same was subsequently furnished. This clear, logical and comprehensive report is so instructive and describes so completely existing conditions, that all portions thereof which are material to this inquiry are incorporated in and made part of the report of this Board. The first extract therefrom, and which is of primary importance to the Commonwealth, is as follows:—

Survey. — Whether the creation of a channel 18 feet deep and 200 feet wide, suitably widened at the bends, which will safely permit 17-foot draft vessels to navigate the river, is practicable, is largely a matter of cost. If the material can be removed by powerful dredges, without drilling and blasting, the cost may or may not be excessive, depending on the yardage, which can be ascertained only by an accurate hydrographic survey from the bar to the point opposite Ward Hill, where it has been recommended that the United States turn over the river to the State for improvement. If large quantities of rock are found by boring it may be necessary to combine dredging and slack-water navigation below Ward Hill; accurate and numerous borings are therefore unavoidable before any definite project or any approximation to the cost of such a channel is possible. While there are reliable maps of portions of the river, there are long reaches for which no reliable data are available. It is intended to avoid duplicating work by using such known data as are available, and supplementing them by new surveys.

The question of cost must be determined within reasonable limits before it is known to what extent co-operation by the State should be asked; it seems, therefore, that the United States should make an accurate survey of the river up to Ward Hill, provided the State will undertake a similar survey for a canal from Ward Hill to connect with the pool above the Lawrence dam. It is understood that there is a considerable State appropriation now available for such a survey, and there is little doubt that the balance would be provided by the Commonwealth of Massachusetts if such provision was made a condition precedent to a survey up to Ward Hill by the United States. By following this course co-operation by the State and federal government would begin at the very start, and there would be good ground

for confidence that the local authorities were thoroughly in earnest, and that the improvement was worthy of being made by the State and the United States jointly.

It is therefore recommended that an allotment for a United States survey of the Merrimac River from Black Rocks Beacon up to Ward Hill, with a view to the creation of a channel 200 feet wide and 18 feet deep at mean low water, suitably widened at the bends, be made; its expenditure to be conditional upon the provision by the State of sufficient funds for the making, by competent State authority, of an accurate survey for a canal to afford 18 feet depth and 200 feet width, suitably widened at the bends, connecting the pool above the Lawrence dam with the channel of the Merrimac River just below Ward Hill. Under no conditions should the United States undertake to make a survey above Ward Hill, even if the State offers to defray the cost; for the legal questions as to State and federal relationships to water powers on that part of the river are so involved that the whole matter of the extension above Ward Hill, survey as well as construction, operation and maintenance of the canal, should be strictly the State's contribution to the improvement of the river.

The views and recommendations of Colonel Abbott having been concurred in by the higher authorities, he was authorized to undertake: —

a survey of the Merrimac River from the mouth to Ward Hill, to be made under the condition that the State shall make an accurate survey and prepare a project, with estimate of cost, for a channel having a depth of 18 feet and suitable width from Ward Hill to Lowell.

It was further provided, and stated in a letter from Colonel Abbot to this Board, dated May 28, 1913, that: —

the survey to be made by this office is to include studies for a channel over the bar at the entrance to the river of suitable depth to accommodate a draft of 17 feet at mean low water. The survey will be undertaken as soon as the proper State authorities have given assurance satisfactory to the Secretary of War that the State will make an accurate survey and prepare the project and estimated cost of the 18-foot channel for a suitable width from Ward Hill to Lowell.

This letter was considered at a meeting held May 29, 1913, and it was "*Voted*, That this Board, acting under authority conferred upon it by the Legislature of Massachusetts and contained in chapter 708 of the Acts of 1912 and chapter 59 of the Resolves of 1913, make an accurate survey of the Merrimac River from Ward Hill to Lowell, and that a project be prepared, with estimate of cost, for a channel having a depth of 18 feet and suitable width from Ward Hill to Lowell," in compliance with the conditions contained in said letter.

This survey and estimate, as well as a project for improvement, have been made and prepared under the direction of this Board, and are described later in this report.

ORIGINAL CONDITION OF THE RIVER, AND PROJECTS, SURVEYS AND EXAMINATIONS BY THE FEDERAL GOVERNMENT.

The Merrimac River, from Franklin in New Hampshire, flows through that State and Massachusetts to the ocean at Newburyport, its length from the outer end of the jetties at the entrance to Newburyport harbor to the boundary line between Massachusetts and New Hampshire being $49\frac{3}{4}$ miles, and its total length about 110 miles.

In its original condition there was a channel 7 feet deep from its mouth to South Amesbury, which was narrow, crooked and obstructed by ledges, bowlders and shoals.

The early projects of the federal government in 1828 were for structures at the river mouth to improve the bar, and the removal of rocks and other obstructions above the mouth.

Among the subsequent projects, surveys and examinations are those cited by Col. Frederic V. Abbot, in his report of March 26, 1913: —

On Oct. 31, 1867, Mr. Henry Mitchell, Assistant, United States Coast Survey, submitted a report in which he described a survey made under his direction by Mr. H. L. Marindin, covering Mitchells Upper and Lower Falls and Hazeltine Rapids. He placed the upper limit of tidal oscillation in the lower part of the Upper Falls. He stated that the river can be made navigable for barges drawing 4 feet, without locks or other expensive structures. After the requisite depths are obtained by excavations, the single difficulty is the strong currents at the Rapids.

On Aug. 16, 1869, Gen. J. G. Foster submitted an estimate, amounting to \$74,887.50, for removing the obstructions at the upper and lower falls, Gangway Rock at Newburyport, wreck of a coal vessel near the mouth of the river, some rocks locally known as the "Boilers" near the city wharves, and for contingencies. In 1870, 1871 and 1872 appropriations aggregating \$75,000 were made by Congress, and Gangway Rock was removed to give a mean low-water depth of $9\frac{1}{2}$ feet, the wreck was removed, and the work was begun and about half completed at the lower falls.

In August and September, 1872, the river was surveyed by Lieut. James B. Finn, acting under the orders of Lieut.-Col. George Thom, who reported that the river could be improved "to permit vessels of 20-foot draft to ascend to Amesbury Ferry, and vessels of 11-foot draft thence up to Haverhill," for \$19,000; also that "nearly 200 vessels, varying from 75 to 400 tons each, passed up the Merrimac for Salisbury, Amesbury and Haverhill."

In the annual report of the chief of engineers for 1877, page 36, it is reported that —

All the work projected for improving the falls of this river above Haverhill, Mass., have been completed to the extent now deemed necessary. . . . Between Newburyport and Haverhill the river has been improved by deepening the shoals and the removal of numerous bowlders which obstructed the channel. . . .

In the annual report of the chief of engineers for 1882 it is stated: —

Previous to July 1, 1881, the work done for the improvement of this river consisted of opening the channel above Haverhill and through "the falls" to the projected width and depth in places where absolutely necessary to make its navigation practicable; also, in dredging at Haverhill, between the bridges, and at Silsby's Island shoals, as well as at Curriers shoal (about 4 miles below Haverhill), and at Rocks bridge ($6\frac{3}{4}$ miles below Haverhill), including the removal of a large number of dangerous sunken rocks at and near Rocks bridge and the head of Silsby's Island; also, in Newburyport harbor, in the removal of Gangway Rock and partial removal of North Rocks, and in the removal from the *channel* of several sunken wrecks and piers.

Appropriations, including the river and harbor acts from 1870 to 1882, inclusive, aggregate \$167,000. This annual report contains also the preliminary examination of Merrimac

River by Col. George Thom, from Lawrence to Manchester, N. H., called for by the river and harbor act of March 3, 1881. The estimate was as follows: —

Mitchells Falls to lower lock at Lawrence, $4\frac{1}{2}$ foot depth, . . .	\$11,000
Lawrence dam to Pawtucket dam at Lowell, 4 foot depth, . . .	225,000
Pawtucket dam to Nashua, N. H., removing boulders, . . .	8,000
Nashua, N. H., to Manchester, N. H., 3 foot depth, . . .	304,000
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	\$548,000

This report was not adopted by Congress.

In the annual report of the chief of engineers for 1885 it is stated that: —

The channel from the mouth to the head of the Upper Falls has been completed in accordance with the adopted project. The excess of expenditure over the original estimate in the execution of this work is \$15,670.09. This excess is explained by the fact that about \$16,000 have been expended in the removal of rocks and other obstructions whose existence was unknown or whose removal was not contemplated when the original estimate was made.

Additional work was recommended in this report, — \$11,500 from the mouth to the head of the falls and \$11,000 from that point to the city of Lawrence, about 29 miles from the mouth.

In the report of the chief of engineers for 1888 it is reported: "The improved channel is in good order, and meets all existing demands of commerce. No appropriation is recommended for the fiscal year ending June 30, 1890." The appropriations from 1870 to June 30, 1888, inclusive, aggregate \$170,500.

In the report of the chief of engineers for 1894 it is stated that —

At the date of this report the project for the improvement of the river is completed, and the improved channel is in good order. . . . No increase of the tonnage of the river is apparent since the improvement was commenced, and no new lines of water transportation have been established.

Appropriations, including the river and harbor act of July 13, 1892, aggregate \$242,366.72, including \$60,366.72 carried by the Acts of 1828, 1830, 1831, 1833 and 1834, taken up in the report of the chief of engineers for 1892.

The river and harbor act of Aug. 17, 1894, directed the

Secretary of War "to make a resurvey of said river, with a view of obtaining a depth up to Haverhill equal to that over the bar at Newburyport."

Under date of Jan. 15, 1896, Lieut.-Col. S. M. Mansfield submitted the report called for by the above legislation. The estimate covered a channel 200 feet wide from the sea to Newburyport, and 150 feet wide thence to Haverhill; the depth was 12 feet at mean low water; the estimated cost was \$1,496,851.07; and the length of the channel was about 20 miles, of which $9\frac{1}{2}$ only required improvement.

The river and harbor act of June 3, 1896, ordered an estimate "of the cost of improving the Merrimac River, Massachusetts, by dredging the channel thereof between Newburyport and Haverhill of the width of 150 feet, and of the depth of 7 feet at mean low water." The report dated May 5, 1897, on this survey is printed, on page 865, A.R.C. of E. for 1897; the estimated cost of the improvement was \$171,442.70. The river and harbor act of March 3, 1899, adopted this new project, and provided \$40,000 for initiation of work thereunder. . . . The river and harbor act, approved June 13, 1902, authorized a preliminary examination with a view to obtaining a depth of 9 feet to Haverhill. The report on this examination by Lieut.-Col. W. S. Stanton is printed in the annual report of the chief of engineers for 1904, page 873, and was adverse, on the ground —

that the small barges, carrying 500 to 600 tons, with a draft of 10 to 11 feet, are going out of use, and that larger barges, carrying 1,500 or 1,600 to 2,000 tons, with the draft of 15 or 16 to 18 feet, are supplanting them. . . . So, by the time the improvement to the depth of 9 feet would be completed, there seems to be little probability that it would enable coastwise coal-carrying vessels to ascend to Haverhill, or that it would materially cheapen the cost of the water carriage of coal to that city.

By June 30, 1905, the 7-foot channel was completed up to the highway bridge at Haverhill. The commerce, in 1904, 76,527 tons, was reported to have increased 25 per cent. over the prior three years; in 1905 it was 88,324 tons; on page 43, A.R.C. of E. for 1906, it is reported that the delivery of coal by water to river points ran 35 to 50 cents less per ton than by rail.

The river and harbor act of March 3, 1905, contained an item ordering "an examination to be made, with a view to providing a channel 12 feet deep between the mouth of the

river and the falls above the city of Haverhill, also including in such examination rocks and other obstructions at the mouth of said river." The report of Col. W. S. Stanton was adverse to the 12-foot channel on the ground that—

"providing a channel 12 feet deep between the mouth of the river and the falls above the city of Haverhill" would not enable coal to be carried through it in ocean-going barges, would not, in my opinion, be of benefit commensurate with its cost, and is not worthy to be made by the United States.

Dredging and the removal of certain ledges were recommended in the report on the survey, the estimated cost being \$62,000. This project was never adopted by Congress.

The river and harbor act of March 2, 1907, called for a preliminary examination and survey of Merrimac River, Mass., "with a view to providing by locks and dams a channel 14 feet deep from the mouth of the river to the railroad bridge at Haverhill." The favorable report of Lieut.-Col. Edward Burr on this survey is contained in H.R. Doc. 2, 61st Cong., 2d Sess. The estimated cost was \$890,000. The action of the War Department was unfavorable to the execution of the project, and it has not been adopted by Congress.

In the annual report of the chief of engineers for 1909 it is stated: "The project [of 1897 for 7 feet to Haverhill] having been completed, it is proposed to apply the appropriation recommended to the maintenance of the improved channel." Since that time all work has been maintenance. Appropriations to date aggregate \$405,366.72; the balance unexpended on March 1, 1913, was \$11,501.98.

The navigable extent of the Merrimac River, and maximum draft that can now be carried at mean low water, is shown by the report of Colonel Abbot to be as follows:—

The mouth of the Merrimac is 54 miles north of Boston. The bar has been improved by two jetties, about 12 feet being now available at mean low water; in smooth weather this affords safe entrance at high tide to coal barges drawing in the vicinity of 17 feet. Between the bar and Newburyport, for depths exceeding $9\frac{1}{2}$ feet at mean low water, the channel is obstructed by rocks and by a middle-ground shoal, with a limiting depth of 10 feet at that stage of tide; with these exceptions 12 feet can be

carried safely at mean low tide in the natural channel to a point about half a mile above the mouth of Powow River and about 8 miles from the ocean bar. A channel at least 150 feet wide and 7 feet deep at mean low water has been dredged from the upper end of the 12-foot natural channel to the railroad bridge at Haverhill, a distance of approximately 12 miles, that bridge being about $16\frac{1}{2}$ miles from Newburyport. Above the railroad bridge the natural channel has a depth of something like 8 feet, and a width varying between 50 feet and 250 feet for about 1 mile; and for the next 1,500 feet to the foot of Hazeltine Rapids a depth of perhaps 3 feet to 6 feet, obstructed by boulders. From Hazeltine Rapids to Lawrence the river is now abandoned by navigation, and people along the banks believe that the 4-foot channel 60 feet wide, formerly excavated through the lower and upper falls, has been filled with boulders. Above the Lawrence dam for about 7 miles up to Richardsons Brook back-water gives gentle current and sufficient depth for naphtha boats drawing 2 or 3 feet; thence to Lowell there is no navigation, but an examination of the river was made from the banks. Great numbers of boulders were visible. Between Lowell and the sea, neither snags nor overhanging trees impede navigation.

Under the heading "Rise and fall of water surface," Colonel Abbot says: —

At any point below Mitchells Upper Falls the elevation of the water surface is dependent at any given time upon four factors, — two natural and two purely artificial. They are the tidal stage at the mouth, the natural discharge in the river and its tributaries, the effect upon that discharge of the operation of the mills at Lowell and Lawrence, and the withdrawal for sanitary uses of water from the Nashua and Sudbury rivers, formerly all tributary to the Merrimac. The withdrawal of water is controlled by the Metropolitan Water and Sewerage Board, charged with the sanitary service of Boston and of the towns lying within the metropolitan water district. The amount withdrawn for sanitary purposes does not vary greatly with the season of the year, but is a constantly increasing draft upon the discharge formerly available for navigation purposes. It varies with the population resident in the metropolitan district. In the non-tidal part of the river the effect of the mills is a maximum at the time of low water, for then they use the pools above the dams for pondage. While the mills are shut down they store water for

use during the hours when they are in operation, thus reducing to nothing the discharge immediately below the dams. In discussing this pondage Mr. C. W. Thom of Haverhill said at the hearing on Oct. 4, 1912: —

I don't want to say anything against Lowell and Lawrence. I suppose they are looking after themselves and must protect themselves. But I did not know there was any such law that allowed them to absolutely stop the flow of this river. I suppose they have so little water that they have to. But for the last three or four years I have been motoring up here for the last few years, and I have seen the river absolutely cut in two at Lowell and Lawrence; not one drop; the flow absolutely stopped. Dams and canals are all right if they will let it go around and over and give us a flow down there. That would be all right. But if it was not for the protection of the tide we would have nothing there. Every week we would have absolutely nothing but mud flats, and we have not much more than that there now. It is something awful there, the stench of the mud.

As the dams were built under State legislation before the United States assumed jurisdiction in such matters, the legal situation is one which is likely to give trouble if there be an attempt on the part of the United States to insist, in the interest of navigation, on the natural flow of the river. Judging from the current literature in connection with the Chicago drainage canal, there seems to be equal or greater question as to any United States regulation of the amount withdrawn from the river by the Metropolitan Water and Sewerage Board.

Below Mitchells Upper Falls the river is essentially a tidal stream during the greater part of the year, with the characteristics during that period of such a stream.

The unusual difficulties of navigation in various sections of the river are described by the engineer officer as follows: —

The bar at the mouth presents the first difficulty. The river carries a certain amount of sediment for 10 miles toward the south, and for many miles toward the north the coast consists of sandy beaches, forming a cordon littoral in front of low-lying marshes. The beach material is easily moved by waves and currents, and the unimproved Newburyport bar had the characteristics usual in such circumstances, — shallow depth (6 feet at mean low water), shifting channel, and heavy breakers, except in calm weather, which in this locality is usual only from May to November; for the rest of the year and at irregular intervals sudden storms are frequent. Two jetties have obtained and

maintained for some years a depth at mean low water across the bar varying between 11 and 13 feet; the channel, while somewhat shifting, seems to wander between more narrow limits than formerly. The mean rise of tide on the bar being 7.68 feet, 17 feet is about the limit of safe draft to which vessels bound to Newburyport can be loaded. On the bar, between the jetties, and at some other points flood-tide currents are very strong at the very time when vessels must enter to take full advantage of the greatest depth. Unless inward-bound vessels loaded to such depths reach the bar just before high tide, they must anchor off the bar, where there is no shelter, and this makes navigation hazardous except in calm weather. The channel to Newburyport has about 2 feet less actual depth than that over the bar, but as there are no waves the available depth is not widely different. Several ledges lie near this channel, which is neither wide nor entirely straight. Near the city there is a large sand shoal which is said to be somewhat shifting as to depth and position at time of freshets. Barges drawing 17 feet are sometimes towed in over the bar by two tugs, and brought up to the city by one tug on a single high water. At high tide Newburyport now marks the upper limit of 17 feet draft. Fourteen feet at high tide can be carried up to Amesbury Ferry, but ocean-going barges of so small draft are getting scarce. For other river points all freights, mostly coal, now break bulk at Newburyport, are rehandled once or twice, according to circumstances, and are loaded on special river lighters of from 4 to 8 feet draft and from 35 to 240 tons burden, owned by the Merrimac River Towing Company, which has a fleet of 16 of these lighters and 3 tugboats. The cost per ton is stated to be 10 cents for use of scows and 23 cents for rehandling (H. Doc. 339, 59th Cong., 2d Sess., p. 4). The present towage charge from Newburyport to Haverhill (16 miles by river) is stated to be about 25 cents per ton of coal. In this 16 miles the unusual difficulties of navigation are mainly due to curvature, comparative narrowness of the navigable part of the channel where it passes through areas of broad open water, the difficulty of keeping such reaches properly marked by buoys or beacons, due to floods, swift currents and drifting ice, and the necessity of having the tug and tow start just before the crest of the flood tide is reached at Newburyport, and "carry that tide up the river." To do this, the rate of progress of the vessels must be as nearly as possible the same as that of the crest of the tidal wave, in order to keep the greatest available depth of water

under them as they ascend the stream. If under these conditions the tow accidentally grounds on rocky or uneven bottom, the tide begins to fall almost immediately, and both the strain on the grounded vessel and the delay are a maximum, for the boat will not float again for nearly thirteen hours, and the tide will fall the full range at that place.

In 1905 the ponding of water in the pools above the dams at Lawrence, Lowell and Nashua was the subject of complaint under section 10, river and harbor act of March 3, 1899. Investigation showed that while the mills were shut down on Saturday afternoons and Sundays the entire fresh-water flow of the river was stopped, at times, for over twenty-four hours. The power company claimed that, due to its large reservoirs further up the river, and its careful utilization of all available water, more water had actually flowed in the five dry months (June to October inclusive) than had been the case for twenty years before the act of March 3, 1899, became law. Observations at Haverhill on Aug. 26 and 27, 1905, by a United States inspector, indicated that the tide was 15 inches lower on Sunday than on a weekday, probably due to ponding. As a final result of the complaint no legal prosecution of the power company was made in view of an *opinion* of the local *United States attorney*, dated July 7, 1906, to the effect that there was *doubt* as to the *applicability of the statute to dams constructed long before the passage of the act* under which complaint was made. By lowering the height of the high water, ponding constitutes a real and unusual difficulty of navigation. If the above opinion of the district attorney be correct, there may be considerable doubt of the right of the United States, without compensation, to take water for lockage purposes from the pool created by the Lawrence dam. For long periods every cubic foot of water so diverted from the pool would be an absolute loss to the power companies; this is proved by the following quotation from page 9 of their protest against a bill introduced in 1907 in the Massachusetts General Court to require them to construct a safeguard above their Lawrence dam: —

Except for a short time after heavy rains there is generally no water running over the dam. All that comes down the river is drawn into the canals and used in manufacturing. Sometimes for a month or six weeks continuously no water wastes over the dam, days, nights or Sundays.

Between Haverhill and Lawrence there is no navigation at all, except for pleasure purposes, and the danger of submerged

bowlders, swift currents and the lack of any objective point which can be reached except for picnic purposes have rendered even this use very slight. About a mile and a half above the city to the foot of Hazeltine Rapids was as far as a naphtha boat could be hired to go at the time of inspection; for the upper half of that distance rocks and bowlders made great watchfulness necessary to avoid breaking the propeller or grounding outside of the unmarked channel. At the time of summer low water the river from this point to the dam at Lawrence becomes a series of detached ponds whenever the natural flow is stopped by shutting down the mills.

At low stages the channel in the 7-mile pool formed by the Lawrence dam has considerable depth and gentle current for the lower 5 miles; for the next 2 miles it is obstructed by large bowlders; from that point to the lower lock to the Pawtucket canal in the city of Lowell, a distance of about a mile and a half, there is no practicable channel, the river being a succession of rapids called Hunts Falls, the fall in that distance being about 12 feet. In the lower 5 miles of the Lawrence pool there is considerable pleasure boating, but no freight traffic so far as could be learned.

Water Power, Co-operation, etc. — The river and harbor act approved July 25, 1912, requires this report: —

to contain such data as it may be practicable to secure in regard to . . . the development and utilization of water power for industrial and commercial purposes . . . *Provided* that . . . consideration shall be given only to their bearing upon the improvement of navigation, to the possibility and desirability of their being co-ordinated in a logical and proper manner with improvements for navigation to lessen the cost of such improvements and to compensate the government for expenditures made in the interest of navigation, and to their relation to the development and regulation of commerce.

The original intent of this legislation was probably to cover the creation of *new* water powers as part of work in aid of navigation, but its wording is such as to justify a very careful study of the question of utilizing, so far as may be economical and legal, the existing Merrimac River water-power developments. The dams and locks on the Merrimac River were originally authorized under a charter of the State of Massachusetts (Vol. 1, Chap. 382, Special Laws of Mass.) which was passed Jan. 27, 1792, the preamble reading: —

Whereas, removing the obstructions to the passing of boats, rafts and masts upon Merrimack River, from the divisional line of New Hampshire and Massachusetts to the tide waters of the said river, will be of great public utility. . . .

Subsequent acts permit purchase of mills and control of water powers (Jan. 27, 1825); require the maintenance of free landings (act of April 7, 1835); acknowledge a quasi-proprietary right in the Locks and Canals Company to the water in the river, by a provision that the water taken by the city of Lowell shall not be sold for power purposes except to generate steam (chapter 435, Acts of 1855); remove the requirement to maintain and keep up free landings (chapter 106, Acts of 1889, and chapter 238, Acts of 1900); and as late as May, 1905, chapter 385, prohibit the Boston & Maine Railroad and others "in any manner obstructing the free flow of water through said canal or the free passage of boats and rafts therein."

The State had thus for over one hundred and twenty-one years defined and prescribed limitations as to the purpose and use of the flowing water in the Merrimac River, guarding on the one hand the rights of navigation, and on the other the rights to the power produced by the dams now owned by the Essex Company. In this connection the opinion of Mr. Taft, Secretary of War, given on Feb. 23, 1907, in connection with the Des Plaines River, is of interest: —

If the State has any control over the water power, which it may exercise in conflict with the claimed rights of the riparian owner, then it must exercise itself, through its own legislation and through its own executive officers. All the United States does, assuming it to be a navigable stream, is merely to protect the navigation of the stream. *With reference to the water power, it has no function except in respect to water power which it itself creates by its own investment in property that it itself owns;* and then, of course, it may say how that water power shall be used. But with respect to the water power on a navigable stream, which may be exercised without interference with the use of the river, for navigation purposes, that is controlled by the laws of the State. It is controlled by the riparian ownership and by the common law as it governs those rights.

(See also report of sub-committee on dams and water power to committee on interstate and foreign commerce, House of Representatives, 60th Cong., 2d Sess., Feb. 25, 1909.)

If the United States had built the dam under its power to regulate navigation, there is little question of its right to charge for the power artificially developed by its structure. As stated

in congressional debates, it could have appointed an agent and have made any agreements with such agent for his compensation, and for repaying to the *United States* the money put into the work, which in making navigation possible also created valuable power. Such an agreement was, in fact, made by the *Commonwealth of Massachusetts* with its agent the Locks and Canals Company, when by special law of Jan. 27, 1825, it allowed that company to acquire mills, real estate, and to conduct manufacturing operations, enabling the company to derive revenue from water passing its dam in excess of the needs of navigation, this being virtually a payment by the Commonwealth in view of the money expended by the *agent* of the Commonwealth in originally building the dams for navigation. The Commonwealth derived its benefits in the shape of navigation at reasonable toll rates established by its own statutes. The Locks and Canals Company derived income from the tolls, upon which alone it originally depended for its income, and later from the sale of water power. In order to pass the Lawrence dam the United States must construct a canal connecting with the pool above that dam; by such connection it will derive much benefit from the artificially created depth above the dam, thereby gaining an unknown but great reduction in the cost of creating a deep channel to Lowell. To operate its canal it must use water for lockage, the lockage water being drawn from a level higher than the natural level of the river surface at Lawrence, by an amount at least equal to the height of the dam. By a high-level canal carrying the upper pool level down the south side of the river to a point below Mitchells Falls, and there locking down into the tidal river, the United States can save the cost of much rock excavation in the bed of the river, which would be unavoidable if the Lawrence dam were nonexistent. Before recommending such utilization of the high-level pool, it has seemed necessary to study and quote such opinions and decisions bearing directly on the relative rights and powers of the United States and the several States as were accessible to the district officer making this report. Up to this time the claim of the United States to water in a river has been held to be paramount where such water is used solely for navigation purposes; with a possible exception being water needed for sanitary uses (see the case of the Chicago Drainage Canal). Does this paramount right cover the utilizing at this late day of the increased level of the water in the pool created by the present Lawrence dam, which was legally constructed about 1848 by the State of Massachusetts through

a legally appointed agent, long prior to any act of Congress asserting the superior right of the United States? The State created the pool originally for navigation only, but later, for valuable considerations, permitted all water in the pool not needed by the State for its navigation to be used for power development by private parties.

Would the withdrawal for navigation purposes of water from the pool by the United States constitute a "taking" for public use, for which payment should be made? Could such a claim be made either by the State or by its agent the power company?

In the State of Ohio a decision of the State Supreme Court, based on the common law, similar to that in force in Massachusetts, reads: —

Hence the State, in its exercise of the right of eminent domain, can subject the waters of such stream to other public uses the same as any other private property, by making a just compensation for the injury, and not otherwise.

Citing this decision in the debate on the Connecticut dam bill (p. 3171, Congressional Record, 1913), it was stated: —

That means the State can* authorize that right to be secured by condemnation proceedings in behalf of a superior public purpose. For instance, to illustrate water power is created, in the first instance, to operate a gristmill or a sawmill, and eventually a big town or city . . . may need the water in that dam for domestic use to supply its inhabitants. That, under the circumstances, would be a superior public right, and the State could authorize the property of the water power company to be condemned for that purpose, but it could not take it absolutely without compensation.

The closely related subject, Can the United States charge power companies for the privilege of building dams and creating power in navigable streams, has been at issue between Congress and the Executive for over four years, and many of the arguments apply to the present question. The veto of several dam bills, and on May 23, 1908, the passage of the Rainy River dam act over such a veto, have a direct bearing. In a committee report dated Feb. 25, 1909, the committee on interstate and foreign commerce, House of Representatives, discussing the subject of a general dam law, say: —

These immense natural resources . . . should be developed for the reawelfare of the country, and not solely for the benefit of those few individuals who had the shrewdness and foresight to acquire such property rights as may be sufficient to dominate and utilize mostly for themselves those privileges. At the same time, due regard must be had to the private rights which such individuals may have acquired, and of which they can *not* be deprived without due process of law.

This report is noteworthy because it expresses the views of an important House committee after it had been considering nearly ten months the veto message of April 13, 1908, in which the President said: —

The present policy in making these grants is unwise in giving away the property of the people in the flowing waters to individuals or organizations, etc.

The Congressional Record for February and March, 1913, contains valuable data on the subject, in connection with the Connecticut River dam bill (S. 8033) which passed the Senate Feb. 17, 1913 (74 yeas, 12 nays, 9 not voting); it contained a clause requiring an annual charge to be paid to the United States by the power company. A charge by the United States against the owners of the same Connecticut dam was an item in the river and harbor bill (H.R. 28180) when it passed the Senate. A similar charge was a feature in another item regarding power derived from a dam built by the United States in the Mississippi River, near St. Paul, Minn. Both items went out in conference, on account of pronounced objection on the part of the House of Representatives to making such a charge; all this accentuates the likelihood of congressional opposition to an item in a river and harbor bill involving a possibility that the United States might have to pay a power company for the use of the high-level pools constituting already improved reaches of the Merrimac River, although in the first instance these pools were, in good faith, created solely for navigation purposes. That grave doubt still exists as to the relations between the federal and State governments in connection with the control of water powers is emphasized by the following remarks of Senator Brandegee on the Connecticut River dam bill (p. 2748, Congressional Record for February, 1913): —

Perhaps half the lawyers in the Senate think one way and the other half the other on this question; perhaps the court itself may divide; but we certainly can never arrive anywhere in the development of our water power, which is now running to waste all over the country, by having the Chief Executive veto all the bills that we pass which do not contain a provision for some sort of compensation, and by having one House or the other block their passage if they do contain it.

Massachusetts is not one of the States in which it has been established as a rule of property, governing riparian land, that more priority of occupation or *appropriation* gives rights superior

to those of the riparian owner in the beneficial use of the waters and the beds of streams. The water-power developments at Lawrence appear to be owned subject to the common law (slightly modified), just as was the case with the Connecticut River dam.

In the report of the Board of Engineers on the 14-foot waterway from Chicago to St. Louis (H.R. Doc. 263, p. 11, 59th Cong., 1st Sess.), it is stated: —

It is the opinion of the Board that the sanitary reasons for the abstraction of water so far exceed and overshadow the commercial reasons that the amount should be strictly limited by the sanitary necessities of the case.

This has a bearing on the question of the abstraction by the Metropolitan Water and Sewerage Board of drinking water from the tributaries of the Merrimac River, of which complaint was made at the hearing in Lawrence as being a cause of extreme low water in the river. At the Lawrence hearing and in the circular distributed thereat an attempt was made to learn whether any charge would be attempted by the Essex Company for such water as might be required by the United States for lockage past the Lawrence dam, but absolutely no reply was obtained. It has since been impossible to get an expression of opinion on this subject from any one in authority. Whether the Metropolitan Board pays the Essex Company for the water they now prevent from entering the Concord River is not known. The Nashua and Concord rivers lie wholly in the State of Massachusetts, and their waters apparently come under the reasoning of Mr. Justice Brewer in the case of *U. S. v. Rio Grande* (174 U. S. 709), where he says, regarding the Croton River: —

Its waters are taken by the State of New York for domestic uses in the city of New York. Unquestionably the State of New York has a right to appropriate its waters, and the United States may not question such appropriation unless thereby the navigation of the Hudson be disturbed.

Before the United States appropriates money for a project involving the use of the pool above the Lawrence dam for navigation and of water from that pool for lockages in a canal below the dam, this right to use without compensation should be definitely settled.

If the improvement were stopped below the dam at Lawrence, and navigation to that point was provided for by excavation

and not by a dam on the river below, as proposed in H.R. No. 9, 62d Cong., 1st Sess., the water surface below the Lawrence dam would be dropped about 10 feet, the fall at the time of low water being thus increased from about 27 feet to about 37 feet, and the power available in like ratio. In view of this increase in available power, an effort was made to learn whether the Essex Company would contribute funds to assist in the creation of such an excavated channel. No formal reply was made, but it was intimated that it would cost so much to lower their wheel pits that no financial benefit would result to the mills, and therefore no co-operation could be looked for from that source. It has been held generally that backing up water so as to lessen the available fall at a power dam by the construction of a new dam lower down the river is a taking of power for which payment is due the owner of the original power dam; that this applied in equity to the United States was recognized in the project of Col. Edward Burr for a 14-foot channel to Haverhill, to be produced by a dam at Lions Mouth, and for that reason the crest of his dam was kept down to 11.14 feet above mean low water at Black Rocks Beacon. On the ground that a 14-foot channel was too shallow for coastwise barges of the present type, and deeper than would be needed for purely river navigation in suitably designed river barges, since locally recognized as true by all parties, that project was not approved by the War Department or taken up by Congress. To give a deeper channel than 14 feet to Haverhill without producing backwater at the Lawrence tailraces would involve at least 3 feet of excavation. With the crest of a dam at Lions Mouth at reference 11.14 all authorities agree that small discharge at low stages and drowning out at high water would render unmarketable and useless any power developed by that dam. As a summary of the water-power situation it appears that the United States might have to pay high for anything adversely affecting existing water-power installations, and that at this time no assistance, financial or otherwise, can be expected by the United States from power developed or to be developed in connection with the improvement of navigation.

Worthy or Not Worthy. — This crucial question includes many factors which can be approximated only within wide and uncertain limits without expenditures for surveys. [Here Colonel Abbot inserts data bearing on the subject, collected, compiled and furnished him by this Board.]

Where such a mass of testimony is available it is not easy to

present a just summary, but it is, perhaps, not unfair to state that (1) the river is now utilized to its last drop for manufacturing; (2) millions of private funds are invested in the dams, canals and factories; (3) dependent on the mills and living between Haverhill and Lowell is a population probably more dense than anywhere else along an equal number of miles of river, navigable or not, in the United States; (4) conditions of manufacturing are such that much of this dense population consists of foreigners of small means, in need of cheap fuel and cheap food; (5) not only is a large population of foreign origin concentrated in this area, but the capital locally invested in manufacturing is very large; (6) agricultural matters hardly enter appreciably into the question, the river farms being within hauling distance of the cities on the river; (7) the total length of river under consideration is only about 38 miles, and the annual value of manufactures along the upper 18 miles, the part above Haverhill, aggregates \$126,186,855, or at the rate of about \$7,000,000 per mile per annum; (8) a project forms no part of a preliminary examination, but sufficient facts have been obtained for this office, by the State Board, to make it probable that at great cost deep-water navigation can be made physically possible to Lowell, or at least to the foot of Hunts Falls, a mile and a half only below Lowell, within easy auto truck hauling of all coal consumers in that city; (9) the river is closed by ice for three or four months a year; (10) no matter what is done artificially to better matters, freshets and violent currents prevent navigation for perhaps another month; (11) full commercial advantage has been taken of the water so far provided to Haverhill; (12) above the point where the tide ebbs and flows no fresh-water discharge is available for days at a time in the open river season; (13) with small appropriations work up to this time has been piecemeal, has been executed with dredges so small as to be uneconomical in every way, and without suitable provisions for safe disposal of dredge spoil; (14) if deep excavation were undertaken large dredges could work, and cheaper prices per yard might make the cost of a deep channel less than the comparison of yards to be removed would indicate. . . .

Present depths on this bar at Newburyport appear to be sufficient for any commerce likely to develop, and to be successfully maintained by the present jetties; to secure greater depths would require their extension to a more or less indefinite extent, with considerable doubt as to ultimate results. It is recommended, therefore, that the present depths on the bar be adopted

as the maximum limit for the improvement of the estuary and river above. The present bar admits steamers and barges of 17 feet draft at high tide. After passing over the bar the channel must be of a depth to permit such barges to reach a point of safe anchorage on the same tide on which they passed the bar. From that point upstream convenience demands 17 feet draft in the channel at low tide, but existing commerce shows that navigation can persist here even up to drafts nearly equalling the depths available at high tide, because the progress of the tidal wave up the Merrimac River is not far different from that at which tugs can tow barges. If 17 feet draft at mean low water be adopted for the inside channel, it would provide uninterrupted navigation for the deepest barges or steamers that now enter over the bar. In case the present jetties eventually secure depths over the bar even as great as 21 or 22 feet, a low-water channel accommodating 17-foot draft vessels in the bay and river would permit the deepest vessels that could then enter to proceed "on the tide" as far upstream as the tidal range remained as great as 4 or 5 feet. For a decision as to worthiness or unworthiness, it seems wise to adopt for the tidal part of the stream a channel which at mean low water would have a minimum width of 200 feet and a minimum depth of 18 feet, such width and depth being considered suitable for boats of maximum draft of 17 feet, for which the channel is designed. Tidal oscillation now ceases at Mitchells Falls, but prior studies indicate that resort to slack-water navigation may be necessary several miles below that point, on account of the cost of excavation. The \$890,000 estimate corresponds with a depth in open channel of 14 feet to Lions Mouth, and 14 feet slack water above to Haverhill, the level of the pool being so selected as to avoid interference with the tailraces at Lawrence, and the dam being of the movable type to give greater assurance against excessive backwater in time of freshets. As the pool level cannot be raised higher than in the 14-foot project, the adoption of 17-foot draft, using a dam at Lions Mouth, would involve excavation in excess of the 14-foot project wherever that project did not provide excess depths, for instance in the upper portion of the pool formed by the dam at Lions Mouth, and for a considerable portion of the tidal section below that dam; from data now available exact estimates cannot be made for either portion, as the character of material to be removed can only be determined by boring sufficiently to develop the amount of rock in place. The selection of Lions Mouth as the upper limit of an open dredged channel for vessels of 17-foot draft is subject to considerable doubt,

however. That depth will admit vessels of much greater tonnage than the 14-foot project, and below Lions Mouth there is some very crooked and swift river, hard to negotiate with such large craft unless it be included in the pool of a dam further downstream. By statute Haverhill marks the upper limit of the 14-foot channel, and by calling for a new survey extending higher up the river Congress has apparently approved the finding of the War Department, that 14 feet to Haverhill is not worth \$890,000, and called for further study of the general question of cost and value of deep water in the Merrimac valley, including Lawrence and Lowell in the problem. . . .

In the above discussion nothing has been said as to possible reduction in cost by providing a less depth in the upper reaches. No recommendation for such a reduction can be made; it simply transfers from Newburyport to some place higher up the river the point where bulk cargoes of coal must be rehandled, and marks the limit of regular steamer service to Boston and New York. The cost of rehandling, the poor economy of small craft as compared with large, and the impossibility of profitably running river steamers for passenger and package freight for the few miles of river between Lowell and the mouth, seem to make such reduction of depth in upper reaches entirely impractical.

As a unit by itself the Merrimac River has no appreciable value, its improvement as part of a route from the cities on its banks to Boston, New York and the south has much value. Whether that value is commensurate with the cost involved can only be known by an actual survey, with numerous borings and accurate levels. The possibilities seem so great that I report without hesitation that the river is worthy of the cost of such a survey up to Ward Hill, about a mile above Haverhill. Above that point the surveys should be at State expense, as they are to do the work if the above recommendations are adopted by Congress.

STATISTICAL MATTER COLLECTED AND COMPILED BY
THE MERRIMAC VALLEY WATERWAY BOARD.

CITIES AND TOWNS ON MERRIMAC RIVER, POPULATION,
VALUATION, ETC.

Bordering on the banks of the Merrimac River are the cities of Newburyport, Haverhill, Lawrence and Lowell, and the towns of Salisbury, Amesbury, Newbury, West Newbury,

Merrimac, Groveland, North Andover, Methuen, Andover, Dracut, Tewksbury, Chelmsford and Tyngsborough.

Under the name of each of these localities is given all statistical and other information resulting from investigations made by this Board, including extracts from advance sheets of the reports of the Bureau of Statistics and of the Tax Commissioner of the State, by the courtesy of the director of said Bureau and said commissioner respectively; stenographic reports of public hearings; report of Col. Frederic V. Abbot, and other data pertinent to this inquiry.

Preliminary to personal interviews, the following circular letters were prepared and forwarded. The answers received have been summarized, and appear under the names of the several localities.

BOSTON, November, 1912.

(1) What amount of coal per year brought by rail is now used by you, and what is the approximate freight charge to you per ton, or what is the cost per ton of coal delivered to you?

(2) What, in your opinion, would be the saving in cost to you, per ton, if the coal which you require could be brought by water instead of by rail?

(3) What amount of freight, other than coal, is now brought to you by rail per year?

(4) What, in your opinion, would be the saving to you, in freight charges, if the same kind of freight could be brought by water instead of by rail?

(5) What amount of freight is now shipped by you by rail which could be shipped by water if the Merrimac River is improved to the extent of providing an adequate channel from the mouth of the river to Lowell?

(6) Do you own, lease or occupy a wharf or landing place on the Merrimac River adapted to use for the receipt and despatch of freight and passengers?

(7) If a project for the improvement of navigation in the Merrimac River from the mouth of the river to Lowell should be carried out providing an adequate channel, would you provide a suitable wharf or landing place on the river for the receipt and despatch of either freight or passengers, or both?

(8) What, in your opinion, should be the least depth in any improved channel of the Merrimac River between the mouth of the river and Lowell?

BOSTON, November, 1912.

The Merrimac Valley Waterway Board, appointed under the provisions of chapter 708 of the Acts of 1912, for the purpose of investigating the subject of the development of the Merrimac River, desires to know whether or not (the name of the city or town being inserted) would be willing — provided the necessary authority therefor is obtained from the Legislature — to acquire by purchase or otherwise, for commercial purposes, land bordering on the Merrimac River, and to build thereon, and equip and operate for public uses, a wharf or suitable landing place to be used in conjunction with an improved river channel of adequate depth from the mouth to Lowell?

A reply to this inquiry would aid the Board in its investigations.

Newburyport.

Population,	14,949
River frontage (miles),	9.7
Total valuation of assessed estates, April 1, 1913,	\$12,617,958
Number of establishments,	49
Boots and shoes.	
Boxes, fancy and paper.	
Bread and other bakery products.	
Other industries.	
Capital invested,	\$6,251,455
Value of stock and materials used,	\$4,531,070
Amount of wages paid during the year,	\$1,807,701
Wage earners employed,	3,378
Value of product,	\$8,039,735

Wharves, Landings, Docks and Terminal Facilities. — At Newburyport the upper wharves, *without railroad connection*, are as follows: (1) above the highway bridge, only abandoned structures; (2) below that bridge and on north' bank, one oil wharf with pipes and pumps to unload ocean-going oil barges into tanks; and (3) one wharf for fishing nets, reels, etc.; on the south bank there are (4) a coal pocket and steam equipment for taking coal out of barges and storing it; (5) a similar plant; (6) boat railway; (7) pier of Merrimac Towing Company, with power equipment for unloading barges and transfer of contents to smaller barges; (8) abandoned wharf; (9) wharf and closed warehouse for package freight, formerly used by a steamer no longer running between Newburyport and Haverhill. Good highways serve the above wharves. The lower wharves *have railroad connections*, and are as follows: (1) large piers and warehouses of Philadelphia & Reading Coal and Iron Company,

with first-class equipment for handling and storing coal; (2) a coal wharf, steam hoist; (3) similar wharf with two covered coal pockets; (4) cold-storage plant, with facilities for unloading fishing vessels; (5) effective coal plant, with three overhead trestles and large storage; (6) a bulkheaded lot occupied by coal piles; (7) lumber wharf and yard; (8) yacht club pier and clubhouse; (9) below this a double-track railroad runs close to the water's edge for about 1,000 feet, but the adjacent water is shoal. There is physical connection between all the lower wharves and the Boston & Maine Railroad, and at the Philadelphia & Reading Coal and Iron Company wharf there is opportunity to load cars by gravity from pockets overhead, or by a steam hoist direct from lighters lying at the wharf. The pockets serve four railroad tracks at once, if desired, each track having a train of several cars loading simultaneously. The other wharves are without such facilities for interchange of water-borne coal to cars, but it is simply a question of making the installation, as the tracks are available. So far as could be learned, there is no contract for interchange of traffic by prorating as to such long-distance traffic as may be desired to be carried partly by rail and partly by water to its destination; in addition to the railroad tracks good highways adequate to present and future needs serve all the lower wharves. There are no wharves in Newburyport which are owned by the public and open to all on equal terms. The private wharves in good repair are almost exclusively used by their owners, in connection with their coal, oil, fish or towing business, and are in consequence not open to all on equal terms. The dilapidated structures appear to be open to any one, but not by any specific authority. The water front of the town below the bridges is fully occupied by existing structures; no considerable area of public space is available for public wharves. Above the bridge is a full mile of unutilized water front, and land can be formed below the town by filling in the flats; the construction of public wharves on some parts of these areas by the State or by the municipality would suffice to insure against monopoly. Before enlarging the present project for improving the river between Newburyport and the ocean, it would appear essential to insure co-operation by municipal or State authorities in connection with this terminal matter.

- Answer to circular letter concerning public wharves. None received.

Answers to questions in circular letter concerning amount of coal used, etc.: —

To question 1: Tons coal delivered, 137,450; price per ton, \$4.36 to \$8; freight rate, \$3.05 all rail from mines to Newburyport.

To question 2: A saving of from 10 to 15 cents was reported. The Philadelphia & Reading Coal and Iron Company, owners and occupants of the largest wharf in the city, are of the opinion that the saving to them would be of large proportions if the river were deepened, since the company has several classes of barges which are now unable to enter Newburyport harbor because of the shallow depth of water. Were the river deepened, vessels with a larger coal capacity could dock at the wharf, and in one cargo the company would receive the same amount of coal as is now received in two of the vessels touching at this port, by reason of the increased capacity of the barges.

To question 3: A total of 9,800 tons. The Standard Oil Company, the owners of a wharf and plant on Rings Island (which island is situated directly across the river from the city of Newburyport), reported that they receive by water 587,309 gallons of gasoline and oil, or a total of 1,792 short tons.

To question 4: The opinion expressed was that the saving would be from $33\frac{1}{3}$ to 50 per cent. Capt. Geo. F. Woodman states that there are 300,000 tons of general freight in and out of Newburyport annually; that the saving to the people of Newburyport in transportation charges would amount to 50 per cent.

To question 5: No answer.

To question 6: Answers disclosed the fact that there were six firms who own and occupy wharves in Newburyport.

To question 7: Answers in the affirmative in almost all cases.

To question 8: As to the depth of the river between its mouth and the city of Lowell opinion was divided. Many expressed the opinion that the depth should be at least 25 feet, while others went so far as to place the depth at 10 feet.

Extracts from statements made at public hearing held Sept. 16, 1912, by the Merrimac Valley Waterway Board, and from letters received: —

FREDERICK L. ATKINSON, coal dealer. I have been wrestling with this problem for about thirty years, and we have succeeded finally in getting about 15-foot draft of water from the ocean to this port. What we need first is to deepen the water on the bar and straighten the channel to this city so as to bring vessels in here of deeper draft. . . . It always seemed to me that Mitchells Falls could be dammed and coal could be carried to Lawrence and Lowell very easily through the locks and canals.

In about 1886, 22,000 tons were taken over those falls at high water. Since then not a ton has ever gone up the river. . . .

We have $2\frac{1}{2}$ miles of water front that can be developed very rapidly. . . .

We have a connection with the railroad now. We have a marginal railroad all along our wharves.

There are several [wharves] now that could be developed right here in the lower harbor enough to handle seven times the quantity of coal that comes in here. . . .

Whenever we have had a steamer line running here from Boston the most freight she ever got has been from this city more than from all other places on the river combined. . . .

Q. Can you give us an idea of how much saving, if any, you could effect by improving the navigation here? A. I think it would lower the water rates all of 15 cents a ton if we had 20-foot draft of vessel. . . .

Q. What is the quantity of coal that Newburyport gets? A. I should say 150,000 tons.

Q. Does that include what is transferred to barges and sent up stream? A. Yes, sir; and shipped by rail and used in the city.

F. K. LYMAN. I am a cordage manufacturer. As a cordage manufacturer I am naturally interested in anything that will boost navigation around here as well as other points, because the amount of cordage used by vessels is decreasing rapidly enough at any rate, and we are of course anxious to hold it firm as long as we can. But while I am interested, I may confess, primarily for our own benefit, nevertheless I am just as much interested, and I think the people who control us, although they do not live in this section, are also interested in the development of this valley and of Newburyport particularly. We have only been here a short time, so that I do not feel at all competent to speak of river conditions except as I have heard others speak of them, but I do think that there is no question, from the experience we have had on the Great Lakes, where I come from, in Cleveland, that the opening up of a harbor, even though it may not be to the very largest of vessels, but to any size which will permit the increase of the number of vessels entering and leaving the harbor, is bound to be of assistance to every point that is touched by those vessels. That would mean particularly Newburyport, I don't doubt, and rightly so, being at the port, the mouth of the river.

So far as we are ourselves concerned, we cannot complain a great deal about freight rates; that is, of the rates themselves. How the other industries are affected I could not say. We have more or less complaint, however, as to the service, and we know that the opening up of this harbor to permit the free shipment of our goods by vessel, and in all probability the free bringing in of all our raw material by vessel, would give us, if not lower rates, decidedly better service. And were there a possibility of getting our goods by water up as far as Nashua, or points above Lowell and Lawrence, it would be also of decided benefit. We have only been selling in New England for the past year, but we hope to do considerable more of it, and we have had more or less occasion to sell up in New Hampshire. Nashua is one of the points in which we are interested, and Lowell and Lawrence to some extent. From the service we have

had to those points, and from what our customers have told us, there is no question but that water transportation to those points would be a great benefit and enable us to do more business.

I know, furthermore, that if Newburyport became anything more of a port, which, unfortunately, it is not to-day, either our parent concern itself, or the men interested in it, with their friends, would be very glad to establish a ship chandlery store here, as that was their original business, and is at the present time on the Great Lakes. In fact, they are one of the largest ship chandlery concerns in the United States. . . .

They would not hesitate at all to put that in here, and I think while that would not be manufacturing to any extent, although it might be in the way of sail and rigging loft, it would employ so many more people and be that additional benefit to the community. Furthermore, we should be able, I feel sure, to make lower prices on account of the freight rates to certain points in the south to which we now ship, and to which we have either to ship the goods to Cleveland in order to obtain a carload rate, and then transship them south, or we have to send them by the best route which we can get to the south, which means railroad to Boston, vessel to the south, to the nearest point to the destination of the goods, and then again by the railroad, and that makes very high rates. For instance, we have to pay, either we or our customer, depending upon what the arrangement is, as much for goods shipped down to Georgia as we have to pay clear around into Los Angeles and San Francisco. That seems very peculiar, but nevertheless it is so. And with the Panama Canal opening up, and the business through that territory taking a spurt as we think it will, it is naturally of interest to us, with those ports opening up, to get as low rates as we can into the southern ports. It is our belief that if Newburyport was opened up, as Mr. Blood says, to tramp steamers of ordinary size, we would have no trouble getting reasonable rates down to the southern ports, and to those inland cities to which we ship from those ports. We would hope and expect to increase our business, which would mean employment of that many more hands, — a thing of course to be desired by every community. . . .

We get our raw material for the most part through the port of Boston. There has never been, since we have been here, with the exception of one small lot that we have bought from England, — there has never been any of our fiber come anywhere except to the New Haven docks in Boston. That means placing it on cars belonging to the Union Freight Railroad, or, I should say, handled by the Union Freight Railroad, and brought around to the Boston & Maine tracks. That means an extra charge of 3 cents a hundred for taking it around the city, to which is added the rate from Boston here, which is reasonable enough, 5 cents a hundred in carload lots. If the port was open for the entry of vessels of sufficient size, because our product is more or less bulky and requires room, we could take it from the New Haven docks into Newburyport and land it right at our wharves, which would be undoubtedly cheaper

for us as well as a great deal quicker. We are frequently held up on our shipments, and that is what we have to complain of rather than the rates. I might add, further, that if power were also added to the benefits of navigation on the river here, we would for our part be very willing to participate in the lower power; because our business does not give in these days any wide margin or profit, and any saving of that kind is very welcome. . . .

GEORGE F. WOODMAN. Newburyport wants a water line, and it is the best chance there is on the coast of the United States to run a passenger and freight service to Boston. But just as soon as you get to running in good shape, — why, I never run more than four months in my life before the Boston & Maine came along and wanted to know who was the moneyed end of the enterprise. They found out, and off she goes. I have been thrown out four times in just that way. I want this river improved because I think it will be a benefit to a lot of people. They should put a dam at Mitchells Falls; that is what I approve of; then you could go to Haverhill and Lawrence with these small barges, like the Lehigh valley barges, of 700 to 900 tons. . . . Lawrence should have had a channel long ago, and then you could take barges from Perth Amboy, Newport News, Norfolk or any of those places and take them right up there easily. . . .

Q. What width of channel do you think we ought to have there?

A. If you can get a channel 200 feet wide I think it would be all right.

LEONARD WITHINGTON. It seems to me that any one who has noticed the transportations of the New Haven railroad cannot fail to see that they have discovered that in order to make the road a paying proposition they have got to spend more of their money in developing the through freight and the through passenger business, before it extends the frequency of train service and the service that they can give on the shorter lines. Now the port of Boston is a great port, but the city and port of Boston are tremendously congested for the handling of local traffic, and in my mind the greatest thing that can be done for the local freight transportation for the smaller cities is to divorce that from the port of Boston to a large extent, relieving the congestion in Boston, where pier rates must be high, where rent and tax rates must be high in proportion to the facilities offered, and divorce a large part of that local traffic to the smaller rivers and smaller ports. I think that one great handicap that New England and this part of Massachusetts particularly has had to suffer during the last fifty years has been the fact that the railroad layout was formed in a haphazard manner because of competition and rapid expansion, and because no general plan was laid out along natural lines. Where in the United States can you find a row of cities producing the amount of manufactured products which is produced in Concord, Manchester, Nashua, Lowell, Lawrence, Haverhill and Newburyport, without a single railroad line connecting the whole section directly? I defy any one to produce a row of manufacturing cities turning out a tremendous product

where no railroad line can collect all that product and deliver it to a single point. Each one of those cities, or each group, has a fan-shaped line of railroads from Boston reaching it, and there is no way of collecting the product of those great cities along one line and shipping it through one port.

EDWARD PERKINS. My business is the lumber business. What little I am going to say on this proposition is simply with reference to the getting of freight down from Boston. If it was possible to have a steamboat line here it could handle the lumber and other supplies coming down, of which we have considerable at the present time. It takes now two to five days and sometimes a week to get anything from Boston. If we had a steamer lying here it would be possible to put material out on the dock in the afternoon and get it here in the following morning. We recently had a lot of grill work shipped from Boston, which started about a month ago. It was sent from Boston to Portland, and then back to Boston, and I got notice to-day that it would be sent from Boston down here. Last winter we had an experience with some hard pine timber which was sent from Boston down here. On tracing it, when it did not arrive, it was found to be in the Salem yard, and the contractor there had taken off some of the large timbers and was using them for moving purposes, which of course was very aggravating. Some of our timber comes from the south and from the east, but we have a great deal that comes from Boston. In reference to the Panama Canal being opened, it seems to me that it is quite a proposition, the fact that lumber can be shipped from the western points right through and up to the Merrimac River. We all know that the freight on shipments of lumber is tremendous; and sometimes a car-load of shingles, sent from the west, will be all stove to pieces before it gets here. If they could come right through by water, I believe they would come in much better shape and at much lower cost. . . .

RICHARD NEWELL. It seems to me that between Newburyport and Haverhill, if you can get a draft of water of 12 feet at low water it would be ample for all the necessities of navigation between here and Haverhill. The up-river cities would not be served by that, except in having their products landed at Haverhill instead of Newburyport. The distance between Haverhill and Lawrence, perhaps 8 or 9 miles, would be lessened about one-half, and perhaps a little more, than it would be if the breaking of bulk had to be at Newburyport. I believe that the only way to reach Lawrence is to have a dam at Mitchells Falls. That is the only place where Lawrence would be benefited. . . .

Nearly a million people are living along the valley and it could be helped if we could get the transportation problem fixed so that it will be much less than it is at the present time. It will help toward reducing the high cost of living, which we are all suffering under to-day, and that is one of the main things to consider.

IRVING BESSE. There is no question in my mind but that if Lawrence, Lowell, Haverhill and Newburyport were able to combine to main-

tain a steamer line, it would be a great benefit to all shippers by making competition with the Boston & Maine Railroad and the New York, New Haven & Hartford line. . . .

JOHN BALCH BLOOD. If the development of the outer harbor was such that an ordinary tramp steamer could come in here, why when a tramp was in another port and could get a cargo for Newburyport, they would come here, and then would look around here to see if they could get a cargo for somewhere else, and in that way we would develop our transportation. But when no tramp steamer can come here, he is not around here looking for something to carry somewhere else. . . . It is necessary, in order to make the proper development, to have a ship that is built practically for this purpose, to run in here and out on a regular schedule. . . . I believe that the handling of the Merrimac River, up as far as it can be, would go a long ways to give the population of this district a lower freight rate, and when you figure it out, the freight rate, — I was figuring the other day, the freight is 3 or 4 per cent. of the manufacturing price of cotton goods. The difference in the water freight and the land freight, what we get for coal, is something like 3 or 4 per cent. of the price.

Haverhill.

Population,	44,115
River frontage (miles),	19
Total valuation of assessed estates, April 1, 1913,	\$39,891,136
Number of establishments,	310
Boot and shoe cut stock findings.	
Boots and shoes.	
Boxes, paper and wooden.	
Bread and other bakery products.	
Cutlery and tools, not elsewhere specified.	
Foundry and machine-shop products.	
Mineral and soda waters.	
Models and patterns, not including paper patterns.	
Printing and publishing.	
Tobacco manufactures.	
Other industries.	
Capital invested,	\$17,202,167
Value of stock and materials used,	\$26,197,058
Amount of wages paid during the year,	\$8,498,786
Wage earners employed,	13,885
Value of product,	\$42,413,255

Wharves, Landings, Docks and Terminal Facilities. — At Haverhill there is a very different condition of affairs. There are some 20 quay walls, locally known as wharves. They are usually from 300 to 400 feet long, and many of them have sufficient depth along their fronts to ensure that barges drawing

10 feet shall remain water-borne even at low tide. In the public hearing held Oct. 4, 1912, it was stated that some of these wharves are public landings, and have been so occupied since the city first secured a charter.

The city now controls several sites with 300 feet or more river frontage which could be made into thoroughly effective public landing places, open to all water carriers on equal terms. At the present time the wharves in Haverhill on the north bank of the river have no railroad connections, but spurs could be run to the wharves without physical difficulty, if such connection were regarded as advisable. On the south bank, in what is now Haverhill but is also known as Bradford, the box board factory wharf has a railroad spur so that it can get coal either by water or by rail. This is true of one other wharf on that bank, though the actual connection is not so complete or convenient for interchange of coal from barges to cars, if such exchange were advisable. I understand that there is, however, no existing contract for interchange of traffic by prorating as to such long-distance traffic as may be desired to be carried partly by rail and partly by water to its destination. Good city streets are closely adjacent to the wharves in Haverhill, and are adequate for all present commercial uses. The city authorities seem to be thoroughly aroused to the desirability of avoiding monopoly, and to be doing all in their power to encourage effective water competition in freight matters. At the hearing and in subsequent correspondence there is ample evidence of the willingness of the municipal authorities and commercial bodies to assist in developing the river, even to the extent of financial assistance in paying for the work.

Above Haverhill there are no existing terminals, but the question of public wharves and terminal facilities was taken up at the hearing in Lawrence.

Answer to circular letter concerning public wharves: —

The city of Haverhill will be only too willing to furnish the necessary landing places for public use in the city of Haverhill and upon the Merrimac River, at such time as the public necessities shall require. The city of Haverhill has, at the present time, some eight or ten public landing places, and several of these could readily be equipped with wharfage facilities. I can assure you that our council will do all necessary things to co-operate with your honorable Board.

Answers to questions in circular letter, concerning amount of coal used, etc.: —

To question 1: Tons coal delivered, 61,485; price per ton, varying; freight rate, \$2.95 all rail from mines to Newburyport, Salem or Mystic.

To question 2: The opinion was expressed that from 50 cents to \$1 per ton would be saved, could the coal be brought by water.

To question 3: This question resulted in a total of 73,700 tons of freight other than coal now received in Haverhill. Many firms answering this question gave the money value of the freight instead of the customary units of weight; as, for example, one firm paid the sum of \$25 in freight charges last year.

To question 4: The opinion expressed is that from $33\frac{1}{3}$ to 60 per cent. could be saved. Many firms, in answering this question, instead of giving their answers on a percentage basis, figured the rail rates and water rates, and gave the answer in dollars and cents.

To question 5: Answers to this question totaled 33,000 tons, but this result is no indication of the amount of freight which could be shipped by water, as many of the firms in answering this question replied as follows: "All of it" (meaning their freight); while others named specific things that they might ship by way of a water route, for example: "9,000,000 feet of lumber," "500,000 box shooks," "12,000 cases of shoes," etc.

To question 6: Many of the firms in Haverhill own and occupy wharves, and all are willing to provide a suitable wharf were the river improved to such an extent as to make it navigable for vessels of fair draft.

To question 7: Answered under question 6.

To question 8: Opinion differs, varying from 14 to 22 feet, but the majority are in favor of a 22-foot depth. The Standard Oil Company have a wharf and plant in the city of Haverhill, and at this point the company receives 853,196 gallons of gasoline and kerosene, or a total of 2,560 short tons. Even in the present state of the river it is possible for an oil-tank steamer to navigate the Merrimac as far as the works of the Standard Oil Company in Haverhill.

Extracts from statements made at public hearing held Nov. 25, 1912, by the Merrimac Valley Waterway Board, and from letters received: —

DANIEL N. CASEY, Secretary of the Haverhill Board of Trade. I understand, Mr. Chairman and gentlemen, that from the standpoint of the Board of Trade investigations have been made as to the present and prospective commerce of the river; and that it would be desirable that a sufficient channel be made so that the larger vessels can come to Haverhill; and the bulk of that investigation is in the hands of your investigator, who has worked with me; and he has obtained all the information which will be of advantage to the Board in preparing its report; and we know a large number of the manufacturers have declared in their statements to me, which I have turned over to the investigator, that were a sufficient channel made, they would ship a large bulk of their freight by

water; and as three-eighths of our freights are transferred at Boston, to be transferred at the Boston & Maine yards to go by water route to the south and west, or go to the south and reshipped to the west, we believe there are other manufacturers who, were this channel established, would swing into line, especially with the opening of the Panama Canal, which will enable them to ship through to the Pacific coast; and they can be shipped to Chicago, St. Louis and other western cities, with which Haverhill has to compete. With a water line established, there would be more refill orders from the places in the west, and the prosperity of Haverhill would be enhanced.

The Boston & Maine, two months ago, informed us that they were going to put on an express freight car to New York. This would take two days. The goods were to go to Fall River and be taken to New York, and be ready for delivery the second following morning. That freight car has made this time on only a very few occasions; it has taken from four to six weeks for those goods to be carried to New York. They are paying express freight rates; and if we had a boat line it would be cheaper and quicker than from four to six weeks. This same trouble is being met with in Lowell and in Lawrence. There is no way to prevent it. The Boston & Maine and New York, New Haven & Hartford railroads form a large railroad monopoly; and something has to be done to assist New England, and especially this portion of it.

Twenty-two per cent. of the manufacturing shippers in Massachusetts outside of Boston are located along the Merrimac River. The Boston & Maine is unable to handle our stuff. Only yesterday there was freight went out of the Haverhill yard that has been tied up for over a week. Shoes and carriages and other things have been left in those freight cars for over a week, waiting to be taken out of here. They cannot ship the stuff; and if we had a boat line it would relieve the congestion, and some of the manufacturers would be able to use the river to compete with the other manufacturers, not only here but in the west. Figures in regard to the shipment of coal are already in the hands of the Board. . . .

There is this about it, gentlemen, that from Concord to the sea is practically a straight line; but there is no direct communication. If a man wants to send goods from here to Concord or Nashua or Manchester he has to take them over the railroad tracks to get them there at all, and a waterway is the natural way for all.

WILLIAM W. EMERSON. The Haverhill Board of Trade has been working for years for the improvement of the Merrimac valley. I want to say, our members believe in it very thoroughly to-day; others have before; and they are forced to that opinion for the reason that our needs are becoming more urgent; our population here is growing in rapid strides, and our railroad is physically inadequate to take care of the commerce that comes and goes here.

I wish you gentlemen might have attended the last meeting of our Board of Trade, which was held in the Elks' Home. We had there one hundred

and fifty members of our Board, of which we have a membership of four hundred. At that meeting there was a perfect flood of protest, from every man present almost, regarding delay in shipments, which could not be handled on account of the present lack of facilities. I think you will readily agree with us that the moment we have adequate water facilities here there is likely to be an improvement in taking freight in and out of the cities in the Merrimac valley. . . . When you gentlemen go down to the next General Court and make your recommendations, I hope it will be at least big enough, broad enough, deep enough, comprehensive enough, so that we can have first-class, ocean-going steamers entering the Merrimac River and going as far as Lawrence at least.

SAMUEL W. GEORGE. I was connected with a steamboat company here for six years; and the proprietors and other men interested in the progress of the river have been before the Board of Engineers in Washington, and also the engineers in Boston off and on for the last sixteen years. . . .

There are certain things that we know. We know that we have a river 700 to 2,000 feet wide between Haverhill and the sea. We know also that we have 85,000 people that live between Haverhill and the Methuen line and the sea. We also know it is a manufacturing valley. We know that the value of the manufactured articles drawn out of this 85,000 people amount to approximately \$60,000,000 a year. All that material has to come through Haverhill; it is imported here; and after it is manufactured it has to be exported. We also know that there is considerable coal and other materials, foodstuffs, wearing apparel, etc. There is from ten million to eleven million dollars' worth of those goods that are imported over here for daily use and daily consumption. It seems to me that has demonstrated the fact that a river from 700 to 2,000 feet wide, with a fall of tide approximately 4 feet rise and fall, that can be made an open artery of trade, and be of great importance to the Merrimac River as far as Haverhill.

Now, if you should carry that further, you would simply add that in the vicinity of Lawrence and North Andover and Methuen there is another 100,000 population. They also are a manufacturing community that turn out articles of manufacture, but more or less of it they do import, and the articles that they do import and articles exported amount to the value of nearly \$70,000,000 a year. They have to have all articles that enter into daily consumption to the value of twelve or thirteen millions imported into those various communities for daily use.

You can go still further and take Lowell and surrounding towns, and you will have to add 115,000 more population; and there is a manufacturing community who manufacture products amounting to \$75,000,000 a year; and they also import for their daily use foodstuffs and coal and other things necessary to the living of people, to the extent of \$15,000,000 annually. . . .

If you could run modern steamers in here, drawing from 12 to 13 or

14 feet, it must be a great advantage to the manufacturing industries of this valley. . . . Our difficulty is the obstacles in the way of this big river between here and the sea, and the steamers cannot override those obstacles. It strikes me if this Board wants to do a real service to the people of this valley they ought to be able to demonstrate what kind of a plan will bring these improvements.

The most satisfactory plan, the most desirable plan, I think, the general idea in this city, the most feasible, is to build a dam and a lock near the Lions Mouth, the narrowest spot in the river. We have deep water to that particular place. If you should build a dam and lock there, so that the water at Haverhill would be as high as the highest tide, or a foot higher than medium tide, then steamers could come to Haverhill, drawing 13 feet of water, and steamers that draw 13 feet of water are ocean-going steamers, and are perfectly safe and perfectly feasible; and there would be no difficulty in having regular steamboat lines between Haverhill, Boston and New York and other places.

Now, if we are going to develop the Merrimac valley, you could also, after your engineers had figured out that scheme, the practicability of which I think there is little doubt, — then you can ascertain what it would cost to build a dam at Mitchells Falls, below Haverhill. Then you could send steamers to Lawrence. Your engineers can figure out what it would cost to put in locks and a dam in connection with the dam already at Lawrence. Then you could have steamers, perhaps not so large a draft, and you could deliver material at Lowell. . . .

If the State of Massachusetts is going into the business of improving the waterways, here is a good opportunity for it to begin with the Merrimac valley. You can very easily see the advantages of this commercially to the State of Massachusetts. . . .

I do think this commission, after their investigation, ought to afford in their report an opportunity for the State of Massachusetts, the people of the Merrimac valley, to know just what these improvements are going to cost. It is not easy to go to Washington with a dozen different forces, all working in a dozen different ways. You have to have some well-developed plan; and it seems to me if this commission should bring about that information and place it before them so they would know what it would cost to put in a dam at Lions Mouth and a suitable draw, and one below Mitchells Falls, and what it would cost to put in a canal to connect with the dam already built at Lawrence, and also the necessary arrangements to keep up the dam, with a lock, then you have done a real benefit to us, and aided in this movement of developing the Merrimac valley. . . .

The city owns, — I cannot define all the city owns; it owns the landing at the Essex engine house, so-called. A dock could be put in there, with certain improvements made, I fancy, five or six hundred feet long in that one place. The city also owns a landing where we used to land our steamer at the foot of the street, but that isn't large enough for any use, except when the city had paving blocks, or something of that sort come up. . . .

I am informed there is a landing also at the city stables on River Street, which is just above the new county bridge, and the old bridge with a considerable frontage there. There would be no trouble about furnishing ample accommodations for everybody. . . .

I won't undertake to say, Mr. Chairman, exactly how deep this channel ought to be. Your engineers have to take into consideration, when they build this dam, the effect it will have on the river. Of course, if we should have 15 feet it will be still better; and if you are going to spend \$500,000 to build a dam for 13 feet, and you can just as well spend another \$150,000 to have 16 or 18 feet, it would be better to do that.

JAMES O'DOHERTY. Now we have been treated from the beginning outrageously by our railroad system. There can be no getting away from that whatever. I bought this year coal for \$1.50 at the mines. Now that coal cost me here in Haverhill \$4.50. Now, gentlemen, you take into consideration the mining process — you have been in these mines and you have seen the kind of work which went into this — and that coal can get aboard the cars at the mines for \$1.50. The train takes that along to Mechanicsville; and I must accept the terms. One carload of 44 tons was to be here in October; one was to be here in the beginning of November; and the two cars arrived this day week together. I have to go in and take these cars from a place that is very inconvenient to handle. We should have something elevated against the cars, what you call the dip-bucket, and it costs a great deal to handle that coal. We were handicapped here in that way from the very beginning; and any person that knows anything about the Boston & Maine and the New Haven, and the whole of them, knows that there is very little respect or love for them in the city in which we live. . . .

We do not compete very much with the south, and a great many of our shoes are shipped abroad to China, as well as to Europe and South America. There are many things that we could receive from the south that would be useful to us. Without asking too much, but asking what I consider honorable, you should take hold of this thing and push it along and make a success of it. It matters not whether you live in Cape Cod or Pittsfield, or where else you live, but take pride in it and say, "I am a citizen of Massachusetts and I want to help every corner of the State as best I can." That is what we want, and that is what I hope we will all get.

J. O. ELLISON. I have been running a steamer on this river for about three years, and I have a pretty good idea of what is needed on the river. I should say that the steamer has been carrying about 600 tons of coal, 650, of about 10½ feet draft. She has been coming up the river during that time. . . .

For my own personal interest I should not be benefited any by having the river improved, but for Haverhill there is no question but a small amount of money spent would be a great benefit to this section. You can readily see this steamer would be quite hard hit if other vessels could

compete with it. So long as we are the only ones that can come on this river, we get the full rate. . . .

We also found that New York and Boston, more especially New York, business men are very much interested to have a freight line to Haverhill. . . .

Now the trouble with the river for coming up and down here with big vessels is the swift current at flood and ebb tides. We now can come up this river easy at $10\frac{1}{2}$ feet. No question about that. People on the river would not allow that to be the case, but we can do that. The great trouble is the tide running so swiftly up and back in places. Rock bridge, for instance, is a very dangerous place. . . .

The way to fix that river is, there isn't any question in my mind, but what a dam should be built, giving us about 14 feet of water. . . .

Mr. HOVEY. If we should make the channel 20 feet would that be desirable?

Mr. ELLISON. Very desirable for Haverhill.

Mr. HOVEY. What width?

Mr. ELLISON. I think the channel is wide enough now; I think they might straighten it in places, and make it as wide all the way.

Mr. HOVEY. What is the average width now?

Mr. ELLISON. About 200 feet. I am not sure of that, but it is quite a good channel. It may be 250 to 150 feet. We should have still water. That is all right for most anything that would come to Haverhill.

Mr. HOVEY. What would you do above here, to get to Lawrence?

Mr. ELLISON. Well, I haven't gone into it thoroughly, and there is only one thing to do, that is, build a canal, some work done on a canal. There is almost a natural way up there. I see where a canal could be put through very cheaply. It seems to me with a very small amount of money expended it would do a great amount of good. It would open up a big lot of real estate here. I would do what I could for the Merrimac River.

Mr. HOVEY. Can you get all the freight that comes in here?

Mr. ELLISON. No, we haven't the room; but we carry some coal; and we can get better freight rates outside part of the time; and that is very desirable; and we charter outside and get good rates; and when we do better we do not come. There are disadvantages in coming to Haverhill on account of the tides, we lose so much time going up and down the river.

Mr. HOVEY. If you had a channel 200 feet wide and 20 feet deep you would not lose any time coming up the river?

Mr. ELLISON. No; 15 feet or 14 feet. We wouldn't lose any time, if the one we had now was reasonably still water. The matter spoken of about the dam affecting the freshets, our experience is you can hardly tell there is a freshet in the river down at Lions Mouth. The dam, I don't think, would do any harm from the freshets.

ARTHUR N. NASON. Open-minded men, either in the Legislature or in Washington, think this is a desirable development scheme. I think

you can do that and I think your Board is working along the right direction; and I think you are going to develop some facts and figures which will open the eyes of the members of the incoming Legislature which will have to deal with your report, or the authorities at Washington who will have to deal with it later on. . . .

A deep channel from Lawrence to the sea might cost more money with this proposition of the dams, and backing water in the dams. You will probably have opposition from the mills in Lawrence if you develop locks and dams, and you will have the proposition of the freezing in the winter months. You must bear in mind you have to get the thing down so fine and so conclusive that you can say to the Legislature to whom you are going to apply for money to carry on this proposition that you have something definite. Your plans should carry two or three different schemes, and a cost of carrying out such schemes.

L. L. H. TAYLOR. I am interested in several ways in this Merrimac River improvement, as a coal dealer and as a real estate owner.

I think if we can have the improvement of this river that we ought to have, which is 20 feet of water, there isn't a piece of property within 2 miles of the water front which will not more than double in value. This matter of the increase of the value of real estate is shown where this matter has been taken up in other places. . . .

You will say, perhaps, we are not doing a great amount of business on this river. It is not what we are doing now, but what we can do. You can't expect to do much on a river when a boat that draws 5 feet of water will drag. The Merrimac River Steamboat Company had a passenger steamer running on the river, and there were times that boat would drag, and not drawing over $4\frac{1}{2}$ or 5 feet, and there were a great many things like that that interfered with the success of that boat. She probably would be running yet if the river was in some kind of shape, but we finally gave it up, and she is now at the dock.

I certainly believe in the lock and dam and 20 feet of water here; and if we simply had a barge, while I don't want to oppose anybody else, I think you will find the pilots and every one else will tell you the lock is the best, because it is going to do away with the greatest currents in the river, which are very dangerous, especially in and around bridges.

FRANK L. BALL. We consume at the present time upwards of 8,000 tons of soft coal a year, and we are increasing in consumption at a rate somewhere between 20 and 25 per cent., so that the matter of advantage of freights on coal and other material, of which we receive from time to time large quantities of heavy stuff, machines and so forth, naturally we would like better conditions in getting freight rates. Better rates would be of very great benefit, but as I said before, the principal interest, one of the greatest interests, I have in the matter would be, it seems to me, that our territory in which we operate would be very greatly benefited by business in general, and the development of manufactures and so forth. With these better facilities our earning capacity would be greatly increased.

HENRY E. WELLS. In view of what the State has already done for the port of Boston and for ports of Massachusetts, certainly this Merrimac valley, which I learned when a boy turned more machinery than any other river in the world, is worth consideration; and as a member of the incoming Legislature I shall do all I can to stand by the report of this Board; and I hope the Board will have no hesitancy if it feels it necessary to ask for further time in order to work out some feasible scheme of co-operation with the national government, to do so.

WILLIAM W. EMERSON. I do not wish to usurp powers that should be delegated to your engineers. A 13 or 14 foot channel does not interest me a little bit; I don't think it does the larger operators in this community. I want 20 feet of water to Haverhill.

GEORGE WARD COOK. This is an enterprising city. In 1882 it was burned over, destroying eight millions and a half of property. Inside of one year every spot was covered over with new buildings. Other cities have many vacant places to-day, and I speak of that to show the activity of the city of Haverhill. . . .

Speaking of lock and dam as against the open channel, I have an open mind. My experience in all these years, in this country and others, it appealed to me, — the open channel. I can see the lock and dam has many advantages to the open channel from Haverhill and Lowell to the sea, and possibly to Lawrence. . . . My judgment, and I have been watching it operate in other sections, would be an open channel, for transportation of freight to the sea, and it would be a great advantage and better than a closed channel.

Statistics submitted, under Date of Sept. 20, 1912, to Col. F. V. Abbot, by the Haverhill Board of Trade.

C. W. Arnold Company, conducting the largest sole leather factory in the world, receive by rail about 30 tons of leather per week and send out weekly 25 tons. Would ship about 50 per cent. by water should reliable line be established.

Between Jan. 1 and Sept. 1, 1912, the Standard Oil Company delivered to their Haverhill station, by water, approximately 2,070 tons of refined oil and gasoline. During the same period they delivered 200 tons by rail. With a 14-foot channel they would be enabled to load their barges to a deeper draft.

The Haverhill Box Board Company uses 45,000 tons of paper stock per year, and if this could be brought direct to their wharf, would have at least half of it come by water. The concern is making over 40,000 tons of box board and a large *quantity* of this, they state, could be shipped by water. They say it does not pay them at the present time to have either the raw material or the manufactured product shipped by water, because of the necessity of having them transferred. The plant uses 25,000 tons of coal a year, 15,000 tons of which is shipped by water. Manager Shortess

estimates a saving of \$50,000 a year to the Box Board Company could they make use of the river.

J. H. Winchell & Co. receive 15,000 tons of freight a year, most of which would come by water during the season the river is open if the service proved satisfactory.

W. B. Thom & Co., hat manufacturers, who use 3,000 tons of coal a year, say they would save lighterage and towage of at least 50 cents a ton with deeper water.

Carter Russell Express Company, who handle the bulk of the shoe shipments, believe that three-eighths of the shoes are transferred to the southern sailing lines at Boston.

The Boston & Maine, on September 3, put on a through freight car from Haverhill to New York, leaving every day, and the average tonnage has been in excess of what was asked for a daily continuance of the car, 7,000 pounds.

J. O. Ellison, a large coal and automobile dealer, who has had much experience on the river and owns a freighter, says that the real benefit would be in having a dam.

The shoe shipments from Haverhill for the year 1911 were 530,592; averaging the weight at 68 pounds, the total tonnage was 18,040 $\frac{1}{2}$ $\frac{6}{8}$ tons.

W. S. Chase & Sons, C. K. Fox Company, Inc., and Ira Webster shipped all their shoes by water when the boat ran in 1902 and many others shipped the larger part by boat. H. E. Guptill said that he made a big saving by shipping by water at that time, and also that it caused the railroad to lower the rate from Haverhill to Boston 2 cents per hundred weight.

Mr. E. H. Moulton, wholesale dealer in meats and provisions, said that during the time the freighter ran the railroad company reduced rates to him 4 cents per hundred or from 9 to 5 cents, and now they charge him 11 cents. Shipping was much more prompt then than now. His freight is 20,000 tons in and 2,900 tons out, total, 22,900 tons.

In 1903 there was for a short time a boat line from Haverhill to Boston, saving from 2 to 12 cents per hundred on freight; but the boat could travel on the river only when the tide was in, having to lay over twelve hours each trip, making the trips so far apart that the scheme was abandoned until such time as she could make daily trips. With 14 feet of water an average of 25 per cent. would be saved upon a large part of our freight.

Freight rates were decreased by the Boston & Maine 2 cents per hundred while the boat was on, but were raised again when it was discontinued.

Many concerns say that they pay at the present time 20 cents per ton for unloading from the barge to the lighter, and 35 cents per ton for use of lighters and towing. This makes a total of 55 cents per ton to bring it up the river. They, of course, have to pay for unloading from the lighters on to the wharf, and this charge would be just the same if it came by barge. It is hard to say exactly what would be saved, therefor, by having a channel up the river, as probably the barges would have to be

towed, so they would still have a towing charge. The concerns would, however, save the 20 cents for unloading, and part of the 35 cents for the use of the lighters and towing.

Over 125,000 tons of coal are annually brought up the river.

Mr. C. W. Thom, of the W. B. Thom & Co., hat manufacturers, expresses the opinion that the river has not been improved, but on the contrary conditions have been made worse by taking the Nashua River out of the Merrimac, and by allowing the river to be absolutely cut in two, and the flow stopped entirely at times at Lawrence and Lowell.

The Haverhill Electric Company receives about 8,000 tons of New River coal at their plant each year. This coal is shipped to Newburyport by barge, there transferred into lighters and towed up the river. That is their total receipt of coal.

Following are number of tons of coal used by dealers and a few of the larger power plants, annually: —

Taylor-Goodwin Company, Haverhill,	20,000
Bean & Watson, Haverhill,	4,000
D. D. Chase Lumber Company, Haverhill,	6,000
H. L. Taylor & Co., Haverhill,	10,000
J. O. Ellison & Co., Haverhill,	18,000
Haverhill Milling Company, Haverhill,	3,500
W. B. Thom & Co., Haverhill,	3,000
Haverhill Box Board Company, Haverhill,	25,000
Groveland Mills, Groveland,	4,000
Geo. C. Elliott, Haverhill,	7,500
Bay State Street Railroad, Haverhill,	5,500
A. P. Jaques (power plant) Haverhill,	1,500
Haverhill Electric Company, Haverhill,	8,000
E. Charlesworth (power plant), Haverhill,	1,100
D. T. Kennedy (power plant), Haverhill,	2,000
I. H. Winchell & Co., Inc., Haverhill,	1,000
Haverhill Water Board, Haverhill,	1,700

Following are a few large shoe manufacturers who will use water route, in all probability: —

H. B. Goodrich & Co., 7,000 cases, 65 pounds each, 50 per cent. water.
Hilliard & Taber, 15,000 cases, 70 pounds each, 100 per cent. water.
Austin H. Perry Company, 20,800 cases, 77 pounds each, 100 per cent. water.
J. H. Winchell & Co., Inc. 40,000 cases, 60 pounds each, 50 per cent. water.
W. S. Chase & Sons, 6,000 cases, 60 pounds each, 100 per cent. water.
C. K. Fox Company, Inc., 24,000 cases, 60 pounds each, 100 per cent. water.
H. E. Guptill, 8,000 cases, 65 pounds each, 90 per cent. water.
F. M. Hodgdon, 30,000 cases, 70 to 75 pounds, 50 per cent. water. ¹
A. W. Greeley would send 100 tons by water.

¹ Probable.

Lawrence.

Population,	85,892
River frontage (miles),	7
Total valuation of assessed estates, April 1, 1913,	\$78,710,803
Number of establishments,	129
Bread and other bakery products.	
Carriages and wagons and materials.	
Cotton goods.	
Foundry and machine-shop products.	
Sausage, not made in slaughtering and meat-packing establishments.	
Tobacco manufactures.	
Woolen and worsted goods.	
Other industries.	
Capital invested,	\$90,437,738
Value of stock and materials used,	\$42,915,080
Amount of wages paid during the year,	\$13,886,514
Wage earners employed,	29,251
Value of product,	\$70,315,376

Answer to circular letter concerning public wharves: —

That the city council of Lawrence, the legally elected and qualified municipal governing board of the city of Lawrence, believing that the dredging of the Merrimac River so that it will be navigable would be of inestimable benefit to Lawrence and its suburbs, do hereby favor the construction of a municipal wharf or pier to accommodate any vessels which would come up the river from the sea in the event of the said river being made navigable, and do further pledge (so far as they are able) the city of Lawrence to the erection of said wharf or pier in the event of the said river being made navigable for coastwise vessels.

Answers to questions in circular letters, concerning amount of coal used, etc.: —

To question 1: Tons coal delivered, 404,495; price per ton, \$4.50 to \$8; freight rate, \$2.25 to \$2.35, all rail from mines to Lawrence.

To question 2: It is the opinion of the various firms in the city that from 35 to 50 cents a ton could be saved were the coal to be received by water instead of by rail.

To question 3: Replies to this question received by the Merrimac Valley Waterway Board totaled 271,635 tons of freight.

To question 4: The opinion is expressed that from 40 cents to \$1 per ton would be saved on freight were a water route available. Many firms answering this question gave a lump sum as the estimated saving; as, for example, "we would save \$1,500 on freight charges."

To question 5: The answers brought out a total of 35,848 tons of freight which might be shipped by water were the river improved so as to make

shipping possible. The tonnage to this question will not do justice to the amount of freight which might be shipped by water because a great many of the business houses, in reply to this question, answered in a general way instead of answering in the customary units of tons; for example, "we would ship all of our freight by water;" "as much of our raw material comes from the south we would make use of a water route;" "one-half of our outward freight of a similar nature." Thus, no light is thrown on the question of what the actual tonnage would be.

To question 6: Only two firms had the ownership of title to land on the water front, but the majority are in favor of procuring a wharf, to be used in conjunction with other firms, for the receipt and despatch of freight and passengers.

To question 7: Answered under question 6.

To question 8: Some placed the depth at 10 feet, while others placed it at 20.

Extracts from statements made at public hearing held Nov. 26, 1912, by the Merrimac Valley Waterway Board, and from letters received: —

Hon. M. A. SCANLON, Mayor of Lawrence. We are a city of 86,000 people here, a large manufacturing city, the value of our manufactured products being larger than any other city of New England outside of the city of Boston. We import a great many thousands of tons of material, and we feel it will assist business men and the community to a great extent by having this work accomplished.

FREDERICK J. SULLIVAN. The city of Lawrence is a city of about 86,000 population; its area is 72 square miles; the value of our manufactured products is about ninety millions; the assessed valuation is about seventy-three millions. The city of Lawrence stands second of the cities of Massachusetts in the value of its manufactured product, and is exceeded only by the city of Boston. Lawrence and the towns about it is the greatest textile center in this country, and is surpassed by only one city in the world, which is Bradford, Eng.

A committee from the Board of Trade interviewed the manufacturers to get some idea of the amount of freight brought into Lawrence, and the amount of freight that is handled here. We are able to learn that the amount of soft coal that is brought into Lawrence every year was something like 425,000 tons; the amount of hard coal, 85,000 tons; lumber, 120,000 tons; groceries and provisions, 17,000 tons; merchandise, such as would be received by the retail dealers in town, 400,000 tons; raw materials, miscellaneous matters, 315,000 tons; and outward freight something over 50,000 tons, so that the figures which were delivered to our committee showed that the amount of freight handled was something like 1,500,000 tons per year. We have, however, been unfortunate enough to get more specific information about the total tonnage which is handled here, which

amounts to the amazing figure of 2,400,000 tons. The receipts from the city of Lawrence for their freight service is \$2,000,000 per year, which is one-twentieth per cent. of the gross earnings of the Boston & Maine Railroad.

If the Merrimac River were opened, as the project is now before the people, as far as the benefit to the city of Lawrence goes it would develop sites for industrial concerns; it would not only enhance the revenue of our city, but also the State and the country.

The question of our railroad and transportation facilities at the present time is something that must be considered in treating this developing of the Merrimac River proposition. We have, as you know, but one railroad in the New England States, which is the New York, New Haven & Hartford. A short while ago a committee from the Board of Trade saw the vice-president of the Grand Trunk Railroad, who had charge of the development of the southern New England Grand Trunk business, and we spent the greater part of an afternoon with him. We were assured that the Grand Trunk wanted to come into New England, and we felt it would be a good thing for Lawrence if we could get some competition. The railroads receive you courteously, but when it comes to remedying conditions, you are about as well off when you return as when you go down. It seems to me the city of Lawrence and New England is in the grip of this great big monopoly, and it seems to me this one little thing which has happened here is about as strong an argument as can be advanced why there should be some competition in the Merrimac valley, and that competition by the opening of the waterway of the Merrimac.

JAMES T. O'REILLY. I should say from the figures that the secretary of the Board of Trade has presented that we ought to be able to save to the citizens of Lawrence alone every year from two million to three million dollars in freight. Now that sum would pay the interest on quite a large expense that might be incurred in opening up this great waterway. . . .

HORACE HALE SMITH. I have made a close study of this proposition on the navigation of the Merrimac River for the last twenty years, and it seems to me it is perfectly feasible, from an engineering standpoint and a navigational standpoint, to open up this river so it can be used as a port, so that Lawrence can be used as a port.

There are several methods of opening the river; some are good methods and some are not. It has often been suggested that a dam at Mitchells Falls or a dam at Lions Mouth would help the navigation, with locks; but it would be a hindrance, and the only good that that would do would be to light-draft vessels; it would be only possible for small craft, barges, and any shipping by way of barges would soon be gobbled up by the New Haven railroad. If we have a deep waterway to Lawrence, some 20 or 22 feet deep at mean tide, we could get steamers to Lawrence, and be saved from being taken up by the railroad, and we could keep an open competition.

From Haverhill to Lawrence on the river to the center of each city it is about 10 miles. By cutting through a canal from the ball ground in

Haverhill to the south of Ward Hill, to a point in the river above Ward Hill station, we would save 3 miles on the river, making 7 miles from center to center of the city. Cutting a dam through the river and up to the poor farm in Lawrence, with a bottom width of 200 feet and on the curve a bottom width of 250 to 300 feet, to allow for the swing of the river, we would have to cut 25 feet, 30 feet below the river bed, and we would avoid ledges at Mitchells Falls. This width of 200 feet would be necessary for tramp steamers and coastwise shipping to allow for the swing of the steamer in making the curves in going against the current. It will be an easy matter to keep in a narrow channel, but in descending the stream it would take more room to maneuver the steamers, especially if they were single-screw boats. When we get to Lawrence it would be a feasible scheme to have a turning basin outside North Andover depot, and arrange for docks just below that, where the training school and soap factory are. There is a large territory down there and good available land on which you could arrange for dockage and trackage from the railroads.

An open-cut canal channel, deep-water channel, will be much better in winter, because there will be less ice in it. A dam would hold the ice in the river longer and interfere with the water power, whereas a deep waterway would increase the water power some 20 to 30 per cent. . . .

Q. Have you investigated the feasibility of going along up to Lowell, for instance? A. Down to Lawrence dam is 14 feet of water, all the way to Bell Grove, and from Bell Grove to Hunt's Rapids is 6 feet of water. I have had occasion to sound there. I had the first gasoline launch in this part of the State, and I sounded the whole river from Bell Grove to Mitchells Falls; 6 feet of water all the way, with one or two exceptions.

Mr. HOVEY. Have you made any plan, outside of what you mentioned, for the improvement of the river, any definite plans of any kind? No, I have not.

Mr. HOVEY. Or drawings?

Not at present.

Mr. HOVEY. Suppose there was a dam at Mitchells Falls, and a lock, how much less would have to be dredged from Mitchells Falls to Lawrence than if there was no dam there, simply a canal and a deep cut?

It would depend upon the height of your dam. You could build a dam 22 feet high and not dredge at all, and that would cut out all our water power.

Mr. HOVEY. Suppose the plan called for upper level of a very few feet above the present level of the river?

You would have to cut a channel about 15 or 17 or 18 feet deep at that.

Mr. HOVEY. The difference would be 5 or 6 feet?

Yes; very little below, between here and the sea; it is mostly at Mitchells Falls.

Q. A dam 5 feet high would back up on the water here? A. Yes.

Q. Is the flow of water regular and uniform, or does it vary? A. In dry time it is very regular, with the operation of the mills. After the mills

run there is a difference. At night when they are shut down it is much less. In the spring there is a large volume coming down.

Q. Have you considered whether or not it would be feasible to dam up the head waters and let the water down? A. I don't think there would be any to spare; the water power takes all they have; in fact, it is not enough.

Q. Couldn't it be arranged with large dams and freshets, so the surplus water could be stored? A. There would be water enough with the present arrangement to hold the dam full at Mitchells Falls. What would come down from the mills would fill the locks, and some to spare. . . .

The only very crooked parts of the river are two places, where the river goes around Ward Hill station, and another at Deer Island. By cutting it off at Ward Hill it takes out one point, and makes the canal almost straight from Lawrence to Haverhill; and there is a possibility of cutting off a part of the large point at Deer Island. . . .

JOHN E. HORNE. I have lived here in Lawrence about forty years. . . . I can remember coal being brought up here by two navigation companies, and I should think it was about time it really was opened up to a good size, and up to date. I was on the committee to gather statistics about the incoming freight, especially iron and coal, and so on, and found that there was about 173,000 tons, all of which can come up here by water from Philadelphia, New York or Boston. It is a very easy matter to ship all of that here. It could be brought in quantities so as to be divided up on getting here, and thus save an enormous lot of freight. . . .

GEORGE DINSMORE. We all realize that one of the greatest means to our industrial life is the rapidly diminishing lumber supply. Few of us realize the fact that the Merrimac valley cities are among the greatest consumers of lumber for the same area in the world. All of our great textile plants use packing cases in great volume; and in this region we wholly depend on the local sources of supply. I will say nothing about building lumber, because I know nothing about that; but I would say the box shops consume from twenty to thirty million feet of lumber annually; the box shops of Lowell use about the same quantity, and in Haverhill a little less. In Philadelphia and other places where they have water routes, southern pine is used in great quantities. The fact that we depend on the local supply works disadvantageously. . . .

M. F. SULLIVAN. Lawrence, with eighty to ninety thousand of people, is a fast-growing community. Just think of Lowell, Lawrence, Manchester, Concord, that furnish most of the cotton and woolen goods of the country. We have such poor means of transportation, simply because the Boston & Maine Railroad has had a monopoly of the transportation. . . .

ROBERT J. MCCARTNEY. It strikes me that if we had the Merrimac River navigable so we could get the heavy portions of our freight here, we would get better results from the Boston & Maine Railroad. The coal men complain of the fact that there is delay in getting the coal here;

they have not the facilities as in Boston. If we could get the coal here in the original vessels, this might be a distributing point, and that would relieve the pressure in Boston. Coal could be shipped from here to Manchester and all the intervening points. It is very difficult to get freight here, and it is very bad for most of the large concerns; they are continually complaining. I am on the committee on railroads from the Board of Trade to look after those things; and I get a great many complaints all the time; and it does not seem to be any use to go to the Boston & Maine Railroad; and the only relief to me would be to navigate the Merrimac River; and that without any dams whatever. . . .

JUSTIN E. VARNEY. I have had some personal experience in shipping freight to Portland, and I can ship freight from Boston to Portland as cheaply as I can ship it from Boston to Lawrence. I can ship freight from Boston to Portland by the Boston & Maine Railroad very nearly as cheaply as I can ship it by boat, all because of the waterway and the vessels going from Boston to Portland. If I want to ship freight from Boston to Dover, N. H., or any place this side of Portland, then I have to pay for it. . . . If we have a waterway for shipping, it will bring the Boston & Maine Railroad to terms.

MICHAEL J. SULLIVAN. I think that with six or seven hundred thousand tons of coal used in the city of Lawrence that the mills could save nearly that much money in their product. Part of that we might expect to go into the profits of the mills, but the greater portion ought to go into the pockets of the people who consume the product of those mills. It is a question which concerns the whole nation. . . .

It is a question, of course, with the congestion of freight that is distressing our citizens now, and it will be worse in the future. There must be another railroad built into this valley. Now, it seems to me the best way would be to build something that would be cheaper than transporting materials over the railroad. It would cost no less than \$6,000,000 to build a railroad to take care of the extra work necessary to be done now. Why not have the government build something cheaper, and not build the railway? I claim it is much better for the government to build a canal, and have it done much cheaper than the railroad could possibly do it. The whole country needs it, we need it.

CYRUS BEEBE. We would like these deep waterways, and from the standpoint of my own line of business, that of building lumber, I can show only the reports from other localities who have the choice of deep waterways, with schooner shipments, — more freight than by steamer shipment, and that has proved a very great advantage in the line of building lumber. . . . It is a fact that shipments of rough building lumber from Canada, and other sections which are coming to be the present sources of supply, can be brought here by schooner shipment much better than they can by rail. It is a fact that a lumber man, if he cannot get schooners to charter, will build one himself, because it is known a schooner will pay for itself in three or four years if properly handled. This deep waterway project appeals very much to members of my line of business.

HUGO BEIL. If this deep waterway was brought about it would help solve some of the difficulties that have been hanging over Lawrence for ten years. One is that the railroad claim they cannot accommodate the manufacturers in a satisfactory manner with freight, and we therefore were prevented from getting a central bridge, and another bridge called East bridge. With a deep waterway Lawrence would have a central bridge, and the railroad could not stand in the way of that project, which is of vital interest to all the citizens. Also, that the saving that would be made to the city of Lawrence, with everything else, in a period of eight years would pay for the expense of that project, so that it would be of great benefit to the Lawrence citizens.

I feel that a deep waterway could be used with no dams; that would be the only feasible plan. Some ten years ago I had a steamboat which came up the river. At Mitchells Falls we encountered a source of difficulty, even with a pilot we obtained at Haverhill to assist us, and that steamer drawing only about 4 feet of water. . . .

I would state that the rails now go down to what is known as the gas company buildings, and by carrying those rails only three-quarters of a mile further, it would give splendid privileges for a large coaling district, wharves, etc., necessary; and also for the upbuilding of more factories. I think it would be one of the greatest blessings for Lawrence.

JOHN HOGAN. I think the deep-water channel up from tidewater will be of great benefit to this city; and I would like to see it come up to Lowell and give us the benefit of it.

J. FRANK JAMES. As a member of the committee appointed to look up statistics in regard to the amount of freight received and sent out, I had an opportunity to visit every wholesaler in the line of groceries, lumber and things of that kind, and I want to say they received us with open arms, and opened up their books and did everything they could to help us; and I did not find a person who was not only too glad to get out and do everything they could to help the matter along. It is a public necessity, and we need it.

In regard to the business of Lawrence, we do not want to look at twenty years ago, and we do not want to look at the business of to-day; but we want to remember that Lawrence, only a few years ago, had 25,000, and it is getting on towards the 100,000 mark. That means that the business is growing. . . .

I think this deepened river affair is going to help not only the people of Lawrence but is going to help the railroad men to handle the business, which they cannot do to-day. Whatever the reason is I do not know, but they cannot handle the business.

I believe the channel should be of an average depth of 22 feet, with turning basins, one in the vicinity of Lawrence, one in Haverhill, and one in Amesbury.

Freight Traffic at Lawrence, from Figures compiled by the Lawrence Board of Trade.

Pacific Mills: —

Cotton,	5,000 tons per annum. ¹
Wool,	5,000 tons per annum. ¹
Coal,	75,000 tons per annum. ¹
Miscellaneous freight,	30,000 tons per annum. ¹
Woven cloth,	5,000 tons per annum. ²

Atlantic Mills: —

Material,	3,750 tons. ¹
Coal,	7,000 tons. ¹
Oil and kerosene,	200 tons. ¹
Manufactured product,	18,000 bales. ²
Waste,	2,000 bales. ²

E. Frank Lewis, wool scourer: —

Coal,	4,000 tons.
Wool, handled,	11,000 tons.

Ayer Mill: —

Coal,	25,000 tons.
Wool,	8,500 tons.

Pemberton Mills: —

Coal,	2,200 tons.
Cotton,	1,350 tons.
Miscellaneous freight,	150 tons.

Washington Mills: —

Coal,	67,000 tons.
Wool,	15,000 tons.
Oil, kerosene, etc.,	15 tons.
Waste,	1,000 tons.

Walworth Bros.: —

Use 30 tons of coal per week.

Farwell Bleachery: —

8,000 tons of coal per year.

Kimball Shoe Company: —

400 tons per year.

Summary of the Classes of Freight, and General Statistics as to City of Lawrence, from Figures compiled by the Lawrence Board of Trade.

The Board of Trade of Lawrence have submitted the following figures for the information of the Merrimac Valley Waterway Board; the results are compiled from letters sent in by the various concerns in the city of Lawrence, with such other figures as were in the possession of the Board of Trade.

¹ Incoming freight.

² Outward freight.

The inward freight is itemized as follows: —

	Tons.
Soft coal,	425,000
Hard coal,	85,000
Lumber,	120,000
Groceries and provisions,	17,000
Merchandise,	400,000
Raw material and miscellaneous freight,	315,000
Total,	1,362,000

Statistics as to outward freight are very meagre, those available to the Board of Trade amounting to but 45,000 tons.

Official figures obtained from the Boston & Maine Railroad, giving the outward and inward traffic in the city of Lawrence, are as follows: inward and outward freight, 2,400,000 tons per year.

The freight receipts of the Boston & Maine Railroad for the year 1911 for the city of Lawrence amounted to the sum of \$2,000,000, which is five per cent. of the gross business of the Boston & Maine system.

Lawrence is the fastest growing city in Essex County; a great manufacturing center on the Merrimac River, which turns more spindles than any other stream in the world; 26 miles from Boston; 20 miles from the sea.

Population, 85,892; polls, 21,737; assessed valuation, \$75,500,000; tax rate, \$17.60.

The focus of six lines of railroads, 30 passenger trains to and from the city daily. Center of a great electric railway plant, controlling 50 miles of track, 9,000,000 passengers a year.

Gas and electricity, low rates for lighting and power. The great dam develops 155 mill powers, 11,896 gross horse-power. Capital of factories using water power, \$15,000,000.

Thirty school buildings, 15,000 pupils in public and private schools; public industrial school.

Two national, 3 trust companies, 3 savings and co-operative banks. Assets of savings banks, \$17,000,000.

A handsome public library of 60,000 volumes.

Ninety-five miles of broad streets well kept, 3 steam rollers and crusher plant.

Sixty miles of sewer. Park system of 136 acres.

A water supply, high and low service, unequalled in the world.

An efficient fire department, 9 fire stations; lowest fire insurance rates in the State.

Forty churches, 1 artillery, 2 infantry companies, in handsome State armory.

A shire town of Essex County, Court House and Registry of Deeds.

Lowell.

Population,	106,294
River frontage (miles),	11.8
Total valuation of assessed estates, April 1, 1913,	\$87,041,693
Number of establishments,	230
Boots and shoes.	
Boxes, fancy and paper.	
Boxes, wooden packing.	
Bread and other bakery products.	
Confectionery.	
Copper, tin, and sheet-iron products.	
Cotton goods.	
Cotton small wares.	
Foundry and machine-shop products.	
Lumber, planing-mill products.	
Patent medicines and compounds and druggists' preparations.	
Tobacco manufactures.	
Woolen and worsted goods.	
Other industries.	
Capital invested,	\$57,414,649
Value of stock and materials used,	\$31,794,009
Amount of wages paid during the year,	\$13,774,880
Wage earners employed,	30,951
Value of product,	\$56,690,584

From Hunts Falls, from the commencement up above the mouth of the Concord River, the Locks and Canals Company have been constructing for many years, and has it now nearly constructed, a long granite embankment. . . . Entering the Concord River, at a distance of about 500 feet, is the commencement of a fine set of locks and canals, and which by three rises puts one above Pawtucket dam. There is a perfect chance for all kinds of wharfage along this new embankment, which is now built by the Locks and Canal Company on either side. The city of Lowell has a large public city landing above the mills.

Answer to circular letter concerning public wharves:—

On behalf of his honor the mayor and members of the municipal council I beg to acknowledge receipt of your communication of January 17, and to say that the same will be fully considered at a meeting of the council to be held on Tuesday, January 28, at 2 o'clock P.M. You will be promptly advised of the council's action, which, I believe, will be favorable.

Answers to questions in circular letter, concerning amount of coal used, etc.:—

To question 1: Tons coal delivered, 184,425; price per ton, \$4.30 to \$8.50; freight rate, \$3.25, all rail from mines to Lowell.

To question 2: The saving per ton was expressed as from 35 cents to \$1, which could be saved were the coal received by water rather than by rail.

To question 3: This question was answered by many merchants, and resulted in a total of 58,365 tons of freight being received by such concerns annually. This total must not be taken as an accurate statement of the tonnage of inward freight (other than coal), in the city of Lowell, for the reason that a great many firms in answering the question expressed the value of the freight (exclusive of coal) instead of expressing the tonnage. For instance, one firm pays annually \$94,000 in freight charges, another firm pays \$24,000 and then other concerns report that their freight bills for 1911 were \$119,500. Other firms, indicated specific property such as 7,000,000 feet of lumber, etc., which is received by them annually.

To question 4: It appeared to be the general opinion, as expressed by the answers received, that the saving to the business concerns in the city of Lowell would be from 50 per cent. if freight could be brought by water to the city.

To question 5: The answers to this question resulted in a total of 11,320 tons. The majority of replies were very general and the amount of tonnage was not expressed. The firms answering, while not giving the amount of tonnage of their freight, replied with such answers as, "would ship all of it," "could ship some of it," and others gave specific commodities which might be shipped by water if a water route were provided.

To question 6: In answer to questions 6 and 7, it appears that no business house has the ownership or control of any wharf in the city. Many firms replied that there were enough city landings, which, if improved and developed, would provide ample facilities for the proper receipt and despatch of passengers and freight were the river improved; and that they (the firms answering) would undoubtedly use these wharfs in conjunction with others.

To question 7: Answered under question 6.

To question 8: Opinion placed the depth at from 10 to 25 feet.

Extracts from statements made at public hearing held Dec. 2, 1912, by the Merrimac Valley Waterway Board, and from letters received: —

MAYOR O'DONNELL. The people of Lowell naturally want better facilities for transportation, particularly for freight transportation rather than passenger, although here in Lowell we at times have some criticism of the railroads for the passenger service; but that is not our present inquiry. But our freight service is not satisfactory as far as rates are concerned, and that is the principal reason the people of Lowell are interested in the deepening of the Merrimac River to make it navigable from Newburyport to Lowell. . . .

I am going to briefly state that we feel that if the river is widened and deepened so that boats may be carried up to Lowell, — if they are carried up at such a cost as not to make freight charges more than at the present time, it will cause competition, and with competition, we feel there will be a lowering of traffic freight rates. . . .

The Merrimac River turns more spindles than any other river in the world, and flows through the greatest textile center in the United States. Lowell, on the banks of the Merrimac, has 320 diversified industries, and 1,000 factories employing over 33,000 wage earners, and manufacturing over 350 commodities representing in value \$60,000,000. The city of Lowell receives through the port of Boston annually over 500,000 tons of coal. The city of Lowell handles annually 2,000,000 tons of freight. We often hear complaints from our manufacturers of the delay of shipments, while freight rates are a continual source of complaint. While referring to the delay of shipments, I will quote from a communication sent out by the National River and Harbor's Congress recently, as follows: —

We already see the beginning of a car shortage which is certain to become acute and may be disastrous. Car shortage means profit shortage, and congestion of traffic brings demoralization of business and increased costs all along the line, in spite of the huge crops and abundant natural resources. The one sure remedy is to put our natural waterways into condition to carry their full share of our rapidly expanding commerce.

With the value of Lowell's products more than \$60,000,000 one may see that with a reduction of the cost of transportation, increased compensation for labor will follow. Furthermore, in the case of many of the necessities of life, it has been truthfully said that the cost of transportation is greater than the cost of production, and reduced transportation would contribute toward the solution of the present-day problem of the high cost of living.

The deepening of the Merrimac would open up new territory for manufacturing purposes, thereby furnishing employment for labor. It would enhance real estate valuation along the river banks. It would reduce the cost of transportation and increase the efficiency thereof, and thus have a tendency to reduce the cost of living. It would bring new capital to the vicinity. It would be of inestimable value to every city and town from Lowell to the sea, and it can be brought about by a comparatively moderate expenditure of public money. . . .

Mr. CUMMINGS. Personally I am in favor of anything you could do to deepen the channel of this river and give the people the best facilities for its development, and I join with the mayor in welcoming you to the city and assisting you in any way I can to carry out your investigations. . . .

Mr. McINTYRE. I have taken some interest in this thing for twenty-five years, and it has always seemed to me it was feasible, and from my talk with various people in Lowell I believe that they are unanimously in favor of it; but they do not know at the present time what the possi-

bilities are, and there is nothing we can say to them that we have the facts to prove.

I sometimes say to them — and it is repeating what others have told me, of course, and not having the facts to prove themselves — a twenty-two-foot deep channel to Lowell would mean that Lowell in perhaps twenty years would equal some of the large manufacturing seaports of England and Scotland. We have got the water, and it would vastly increase this whole region, but I cannot prove what I say; the only thing we can wait for is for a true report on what can be done and what it is going to cost. It seems to me that the people of Lowell and the other communities around here will be unanimously in favor of it, and will pay their share of the taxes, being willing to go down into their pockets even though they haven't a dollar's worth of freight. It will not only settle the question of keeping freight rates within bounds, but it is going to make freight for the railroads or shipping lines, if we can get them in here to do it. . . .

MR. McMANINON. There is no question in my mind but this Merrimac River should be deepened, and why it would not mean twice the city of Lowell in the future. There is from Dracut and Tyngsborough to Lawrence a part of the river really isolated, with no chance for mill purposes or anything.

I am closely related to the agricultural end, and we people in the Middlesex North Agricultural Society have discussed this thing with particular reference to the advantage it would be to get produce into the Boston market to meet the competition of the State. It is there and the transportation holds it, and there is no reason the stuff should have to be teamed to Boston. Lowell is over-glutted with stuff, and the progress of agriculture is held back. . . .

One gentleman made a statement that there are men now interested enough to have boats running, who want to send them up to Lowell and take the products of the country, and are anxious to know when there is a possible chance to have them do that. It seems to me the products of the Merrimac River are in demand in the southern country, and it seems that with the great amount of property and value and power that the people of this territory are entitled to consideration; it ought to be considered for a moment in its opposition to such a project — when they can go down south and in a little stream get a million dollar appropriation for it. . . .

JOHN H. MURPHY. Mr. Chairman, — and with thanks to the mayor, — the apathy of the people of the Merrimac valley as regards the development of the Merrimac River is of such a nature as to be almost unbelievable. Save for the spasmodic public hearings and the newspaper editorials little is heard of that project which means so much to this section from an industrial and commercial standpoint. The advantages to cities having both rail and water connections are so many that to exploit them would require considerable time. Would the present famine and unfair prices

demanding for coal exist in the Merrimac valley if it were possible to bring our coal by water? Is it not a fact that at points having water and rail connections the railroads equal the water charges? I ask you to take Boston as an example, or other ports, and I ask you to compare distances and rates, and see how the people of Lowell pay dividends to the railroads on their purchases of coal. If we had coal coming up the river, how soon an excuse would have to be made to take the place of the "car shortages" that we hear so much about.

But developed waterways are no longer considered obnoxious by the large railroads; they have become necessary in order to handle the ever-increasing freight, and if this community is to advance or ever hold the pace the Merrimac River must be developed. The task is reported by expert engineers as feasible, and in this century any problem can be overcome by engineering. All that is necessary is enthusiastic work to secure an appropriation to carry it along. A trip to the central and western parts of the country will convince any one of the importance and the feasibility of developing waterways. It is not stretching the point when we say that with respect to some rivers the engineers go back to Washington and say that the creeks ought to be paved, rather than developed, and we have no means for transportation and yet allow it to go by default.

Many complaints are made by shippers and consignees in regard to present freight service, and what is the outlook for improvement? On November 19, the regular freight due to arrive from Boston, and supposed to be ready for delivery at 8 A.M., did not arrive until 7.30 P.M. This is only one instance of poor service, but there are so many other cases of such a nature as to impress upon the minds of the merchants and manufacturers that freight service must be improved, and that the people of this valley must look forward to the time when they will utilize the natural facilities of transportation by means of the development of the Merrimac River.

Our river banks and canals are provided with public landings, and our canals are equipped with locks capable of locking boats up to 100 feet long. These facilities were provided years ago by the founders and early settlers of Lowell, who must have had an idea of the possibilities of the Merrimac. Concerning public landings, there is one on First Street, now almost built upon at the junction of Perkins Street, available, and at the back of the police station we have a public landing. Then at Thompson's Falls we have a public landing where it is equipped with railroad siding.

Mr. SUTHERLAND. Would it be easy to connect those landings you have mentioned with the railroad?

The one at Thompson's Falls is already connected. The one at First Street was doomed to be connected by the Grand Trunk, and the one at Perkins and Pawtucket streets is probably not reached unless there is a development on the north bank of the river, unless by a bridge.

Concerning the present prospective commerce, the business of Lowell to-day would warrant the expenditure of the estimated cost, and it is a conservative basis of figuring to imply that enough money would be saved

on reduced freight rates to repay the government in twenty years for the expenditure.

Lowell's diversified factories manufacture annually over \$60,000,000 worth of products which are distributed all over the world. There is received and forwarded over 2,000,000 tons of freight and 10,000 tons of express matter annually, which is sufficient to warrant Massachusetts or the United States government in making an appropriation of money sufficiently large to make the Merrimac River navigable to the sea.

Speaking of what one dollar will do in freight movements, we know that one dollar will transport on a level road one ton for a distance of 4 miles; we know that on an improved road one dollar will transport a ton for 10 miles; and that on a waterway one dollar will transport one ton 1,250 miles — from figures obtained.

I had recently the privilege and honor to appear before Colonel Abbot in regard to this matter, and I will file with your clerk a copy of this speech, parts of which I desire to read at this time.

The Lowell Board of Trade is represented here to-day to advocate the carrying out of the above recommendation and to present facts concerning the possibilities of making the river navigable above Haverhill.

The interest of the people of the Merrimac valley and especially in Lowell, in the project of making the river navigable is aroused when they realize that the cities of the Merrimac valley are unable to compete with other manufacturing communities enjoying water-transportation facilities.

The importance of this project may be estimated when we realize that the Merrimac River turns more spindles than any other river in the world, and that the Merrimac River flows through the greatest textile center in the United States.

The growing importance of the industries of the Merrimac valley demand study and attention, and the cost of the project is not incommensurate with the advantages to be derived. The cost of the project should have little weight. The Ohio River, for a 9,900 mile 9-foot project, received this year a partial payment of \$5,870,000 on a \$63,000,000 estimated project. New England, and especially Massachusetts, has received but a small share of the total appropriations made by the government for the improvement of waterways. For example, Massachusetts, with a wealth twice as great as that of Texas, and a population about the same, received in 1910, \$745,000, while Texas received \$3,542,000, or five times as much. In the last appropriation of 1912 Massachusetts received \$431,000 and the State made an appropriation for the development of the port of Boston of \$9,000,000, while Texas this year received from the government \$1,680,800.

"The development of the Trinity River in Texas contemplates an ultimate depth of 6 feet for a distance of 511 miles upon which there is at present absolutely no commerce, and the ultimate cost of which is estimated at \$4,550,000."

The development of the Brazos River is costing \$200,000 to remove overhanging trees and snags, and carries on no commerce, and travels

through an unimportant agricultural country. The development of these two rivers in Texas are two shining examples of developing future commerce or glittering examples of representative, active, political work.

The Merrimac River project is insignificant in comparison with such expensive undertakings. While the commercial benefits to be derived from the desired improvements are held to be entirely prospective and speculative, it appears from reports of improvements in other rivers that are not so large as the Merrimac, and do not flow through such an important industrial section, that freight rates have been reduced, shipping congestion has been relieved, and business improved.

The establishment of competitive rates by rail and water result in a saving to the manufacturer, and in this particular section competition with a single railroad is sure to bring about reduction of rates and more efficient service.

The development of the intercostal canal from Boston to New Orleans, as advocated by the Atlantic Deeper Waterways Association, is the trade avenue through which Lowell can have its supply of cotton shipped from the cotton belt to the mills of the city by means of the Merrimac River, as well as to receive other raw materials in large quantities from the south and west. Should such a waterway to the cotton fields of the south be opened for business, as it probably will be eventually, the city of Lowell would be wholly unable to compete with textile cities on the coast unless the Merrimac River is made navigable to the sea, for the reason that cities having the advantages of water transportation can get their raw materials at low freight rates from the cotton fields of the south.

The completion of the Panama Canal will bring to our ports the cheaper grade of manufactured commodities from the Orient, and if the New England manufacturer is to compete with the low cost of production with the Japanese, in comparison with the American-made goods, the great textile centers of New England may lose their supremacy.

The value of the river made navigable from Lowell cannot be estimated from the volume of business done on a 9-foot channel from Haverhill to the sea.

Lowell with its 320 diversified industries and its 1,000 factories employing over 33,000 wage earners, manufacturing over 350 commodities representing in value over \$60,000,000, must be given the attention by the United States government that it is entitled to, and the position that Lowell occupies in the State and country can only be maintained by receiving appropriations which will adequately develop and help to properly utilize her natural resources.

There is received at Boston by water, exclusive of coal, over 18,000 tons, and there is shipped from Lowell through the port of Boston annually over 7,600 tons, and there is received for Lowell through the port of Boston over 500,000 tons of coal a year. Lowell ships to New York via Long Island Sound 24,000 tons, and receives from the port of New York about 23,000 tons.

The records obtainable from the railroad officials indicate that about 2,000,000 tons of freight are handled annually, both in and out of the city of Lowell. That can be taken as coming from railroad officials.

If you can assume that one-half of the 2,000,000 tons of freight will be transported by water at a saving in charges of 10 cents per ton, you can figure a saving of \$100,000 a year; and figuring on an estimated cost for making the river navigable of \$2,000,000, it would require about twenty years to save enough in transportation charges to warrant this expenditure.

Manufacturers often complain of the delay of shipments, and freight rates are a source of continual trouble. Many manufacturers have expressed themselves as being in favor of securing water transportation, and would utilize the river for receiving raw materials and shipping finished products. The value of Lowell products equalling more than \$60,000,000 furnished a basis upon which to figure that if the transportation charges were reduced because of the use of the river it is quite easy to expect increased compensation for labor.

If New England is to maintain her supremacy as an industrial center, which she is able to-day to hold by reason of her unlimited supply of labor, capital and intellect, the avenues for reaching the crude or raw materials must find a way to the manufacturing community besides the railroad, and the development of the canals and rivers hold the key to the situation.

The Board of Trade of Lowell agrees that the improvement of the Merrimac River will develop new territory, will enhance the value of land and real estate, will reduce the cost and increase the efficiency of transportation, and will have a tendency to decrease the cost of living and open new fields for the employment of capital and labor.

There is no question but what the cotton used in the mills of Lowell, which provide employment for 27,000 people, could be brought in barges up the Merrimac River, and in four particular cases unloaded at the doors of the mills. These mills have intimated that they would be very glad, of course, to reduce the transportation charges.

Mr. CUMMINGS. You mean through the canal?

Mr. MURPHY. Come up in a low barge, up under the bridge.

The Locks and Canals Company have spent thousands of dollars picking away at the ledge at Hunts Falls; they have made a basin there which is a part of the water pond for the city of Lawrence. There are places in the Merrimac River that are 15 feet to-day, made by the Locks and Canals Company to store water. I don't know the attitude of the management of that company. I wrote them to furnish Colonel Abbot information, maps and blue prints of the Merrimac River, and I received a reply that Mr. Mills would be glad to show Mr. Abbot or this commission any maps he had at his office; and in talking with Mr. Badger he informed me that if possible this commission might come there and inspect maps of the bottom of the river.

Mr. CUMMINGS. They might inspect the river from Pawtucket Falls down?

Mr. MURPHY. I don't think any engineer who has made a report has ever stepped into the water; I think it has simply been to entertain these men and rave about the beauties of the stream, the historic importance of it, and have the engineer go back to Washington and say it is a good river, but that he could not get the people interested.

This thing has been a burning question for years, and as was remarked at the last hearing we had in endeavoring to work up enthusiasm, that it would continue to be the question for fifty years. To my mind that is not true, and what we want to do is simply to get behind our congressman for this district and have him stand up in Washington and fight.

Mr. CUMMINGS. It is twenty-five years since the Board of Trade began the agitation.

Mr. MURPHY. In fact, the influential men of the city have said it is practically a useless job. But when you go to New York and ride from Buffalo to Philadelphia, and observe that canal and see the amount of traffic that is going on there, even to-day, with old barges being pulled by mules; and they have plenty of railroads down there, — they are not in the grasp of one road, and yet they tolerate them.

We may be hitting all over the question and not getting down to facts, but if there is anything the commission desires to know I am willing to put my time digging up any special point they are interested in.

Mr. SUTHERLAND. May I ask what is the depth of the water above the dam here?

Mr. MURPHY. That varies; there has never been a survey above the dam.

Mr. BARRETT. Seven feet; I think they have run a steamer that draws 6 feet.

Mr. SUTHERLAND. How far does that extend?

Mr. BARRETT. To Nashua.

Q. What is the character of the bottom, do you know?

Mr. BARRETT. Mostly hardpan and some places rock.

Mayor O'DONNELL. I want to say that Commissioner Cummings refers to the fact that the Board of Trade has been agitating this twenty-five years without apparent success. It seems to me it has been comparatively successful; this is the first commission we have had to look into the subject, so there has been some success.

Mr. BARRETT. I am much interested in it, and I think every man in Lowell should be interested. We have the first canal used in the United States for transportation purposes, a canal made to connect Concord and the Merrimac River, which was dug in 1792, and on that canal were a number of free landings, two or three of them have been stolen from the city of Lowell, one of them, by the corporation referred to here very extensively this morning, and many here will remember about the abolition of free landings on Western Avenue.

As far as the navigation of the Merrimac River is concerned, to any man who has traveled over this country and seen the other rivers and streams

made navigable, there is no question about the feasibility of making the Merrimac River navigable. There is no question about the desirability of the city of Lowell having navigation or water communication when you consider the fact that it costs 80 per cent. of the cost of bringing coal to Lowell from Newport News or Norfolk, Va.; 80 per cent. of the cost of bringing coal from there is added on it again from Boston to Lowell. In other words, we can bring it for \$1 a ton in bottoms from Norfolk to Boston, and I have had thousands of tons come to Boston for 90 cents, but it will average about \$1; it depends a good deal upon the condition of shipping at the time; sometimes bottoms can be leased at a less price. And it is 85 cents from Boston to Lowell, and I think that the cost of bringing coal from Boston to Lowell is the highest in the United States; I don't think there is a place in the United States, and I have endeavored to find out, and I have not yet been able to discover any place in the United States where the cost of transporting coal is as high as from Boston to Lowell,—over 4 cents a ton per mile, which is almost prohibitory, even when the cost in this country is only a cent a mile where they have long hauls. This is a comparatively short haul, and on a road that not only has a tremendous freight-carrying trade but has also a large suburban passenger travel, which also enables the road to pay dividends. I think the suburban traffic of the Boston & Maine is as large as any road in the United States in their passenger traffic.

Now the river between Lowell and Lawrence presents no feature that would confuse or hold up engineers from enabling it to be a stream suitable for from 6 to 8 feet draft. The canals here at Lowell at the present time, I understand their charter now compels them, if you come up the Merrimac River in a boat, instead of opening the canals at the locks they will take your boat and put it in a wagon. All the landings are feasible for railroad connections; the landing on Perkins Street,—an extension of less than half a mile of railroad tracks would reach that Perkins Street free landing—yes, it is less than a quarter of a mile. Their locomotives go to this landing, and the landing on Broadway is already connected.

The only thing in this matter, and the only fight in this matter, is the fight of the people who do not want water connections. It is not a question of engineering; I don't think any engineer of standing in the United States would go on record by saying that there was any difficulty for a 6 or 8 foot draft from Newburyport to Lowell. But the question is and always has been, an organized opposition in a very small body can always beat a large disorganized movement, and that has been the trouble, I believe, in Lowell. The question of water rates and railroad rates cannot be discussed by any intelligent men; the history of the entire country shows that water has developed the country; it shows the entire west was developed on the lines of the streams, the Ohio River, the Mississippi River, and all the different streams flowing west of it,—the line of colonization follows the streams showing the natural tendency of men so to follow the rivers; and men living to-day will remember when water transportation was almost the

sole method of transporting freight and material, so it is not a new question. The history of the Great Lakes and Buffalo to-day, taking the flour industry from Minneapolis and St. Paul, proves the advantage of water rates. Buffalo is to-day, or in a short time will be, the largest flour city in the United States, owing to the fact that it can transport wheat by water, and instead of grinding it in Minneapolis they are grinding it in Buffalo. And so all over the country the water-freight and water-transportation question is the great question. I have not the figures, but I question whether there is any place in the United States within a distance of 25 or 30 miles that contains the number of manufacturing plants and the number of freight-using communities that the Merrimac valley has. Within a very short distance you have a string of large manufacturing communities that this river would immensely benefit, not alone in the fact that they would get their freight by that river, but in the fact that it would give us competition with the railroads that now have these great manufacturing communities by the throat. Only two or three weeks ago I wanted to bring a piece of freight from Springfield and it took sixteen days. I could send over a yoke of oxen and do it quicker, and the only satisfaction I got was the statement by the railroad that they were doing the best they could. But they have the railroads loaded down so heavily with stocks and bonds they cannot issue much more against them. They have got to keep the tariff up as high as they can; and if you were to squeeze the water in these railroads out you would have water enough in the Merrimac River to float a battleship. The manufacturing communities of Lowell and vicinity are suffering, and if the Locks and Canals Company are left alone, in a few years more they will have it going through a sewer pipe down below the bridge. If any intelligent body of men will study the river, starting at the State boundary line, they will find enough water in the river, and no engineering problem they cannot solve; it is simply a question of whether the New York, New Haven & Hartford Railroad is stronger than the people of the Merrimac valley; that is all the question involved in this issue.

Mr. CUMMINGS. There is no question but that the people of Lowell will almost unanimously instruct their present congressman to do whatever is necessary to help you deepen the channel of this river, and I am one to have that put before the people by vote of this municipal council, to show that the people of Lowell want that project if they can get it or something like it.

Mr. BARRETT. A 6-foot barge waterway from Newburyport to Lowell would be worth to the city of Lowell, conservatively, \$50,000 a year; it would be worth that much to the city of Lowell not only in freight coming here, but in the better service and lower freight rates, and better conditions that would immediately apply to the railroads, if that were here.

Now, that is 5 per cent. on \$1,000,000. How much it would be worth to Lawrence I don't know; but when you consider the fact that for twenty-five years they have been appropriating in Washington hundreds of millions

of dollars for the improvement of minor streams and water works throughout this country, — places where Mr. Murphy says they are streams four months in the year and the rest of the time a ditch, — it seems to me there ought to be influence enough in Massachusetts, with its 4,000,000 population, to secure a reasonable appropriation for the starting of this work, and a reasonable appropriation might mean \$1,000,000 or \$2,000,000. They are now considering the opening of the Connecticut River to Springfield. . . .

The river is now navigable as far as Hartford for certain kinds of shipping. Now, if this commission, appointed by Governor Foss, will look into this matter and give it very careful attention, as I believe you are doing and will do, and if the United States government does not take hold of it, let the State of Massachusetts make a start; and if the start is once made it seems to me that a great deal of difficulty would be overcome in beginning something. We have had men here for twenty-five years, ever since I was a boy, — why, General Butler is on record in some of his papers on some matter at Washington in relation to the navigability of the Merrimac River, and it might be well to get General Butler's statements on this matter at the time he was congressman at Washington. He had gone into the matter very carefully and got engineers at the time, and he had figures bearing on the cost of the work at that time; he would be also an authority on the free landing proposition in the city of Lowell. When the city of Lowell took the water from the Merrimac River for water purposes in Lowell, General Butler was counsel for the city of Lowell at that time, and at that time, if I remember rightly, from my reading of the matter, he at that time spoke of the immense value of the free landings in the city of Lowell, and that they should never be surrendered to anybody, but be kept open and belong to the citizens of Lowell. He went into this matter very extensively, and I have not any doubt his data and matter would be of value to the commission, because he made a study of it at that time; and if we had a man like General Butler here now I do not think there would be much trouble in getting an appropriation for making the river navigable. We elect congressmen and senators and expect them to use their efforts to benefit all the people of Lowell instead of electing postmasters, etc. . . .

Mr. MARTIN. . . . The Merrimac River from Lowell to the sea should have a channel, in my opinion; not a 6-foot channel, Mr. Barrett, but a 14-foot channel, or perhaps even greater, if the engineers deem it feasible, and I suspect they may. A channel sufficient to bring ocean bottoms from Newburyport to Lowell would rebound immensely to the growth of this section, and would take care, to a very large extent, of the surplus business which the growth of this section in the next fifty years is going to produce.

Mr. McINTYRE. I would like to make just one statement. I am perhaps better acquainted with the river between Lowell and Nashua than any part, and I will stake my reputation on the fact that there is already

enough water in the Merrimac between Lowell and Nashua to take care of the biggest Mississippi steamer on the Mississippi River to-day, without any deepening of the channel, — simply blow a hole in the old dam at Tyngs Island.

Mr. BARRETT. Just one word about the depth of the channel. I think that the first question of all is to get the river open, whether it is 20 feet, whether it is 8 feet or 21 feet, — get it open from Newburyport to Lowell. The development of the trade when it is opened will show and will produce a demand for the deeper channel if necessary, but get it open first.

A letter from the Lowell Board of Trade, presented at the hearing of Oct. 4, 1912, before Colonel Abbot, states: —

The interest of the people of the Merrimac valley and especially Lowell, in the project of making the river navigable is aroused when they realize that the cities of the Merrimac valley are unable to compete with other manufacturing communities enjoying water-transportation facilities. . . . The Merrimac River turns more spindles than any other river in the world. . . . The Merrimac River flows through the greatest textile center of the United States. The Board of Trade of Lowell agree that the improvement of the Merrimac River will develop new territory, will enhance the value of land and real estate, will reduce the cost and increase the efficiency of transportation, and will have a tendency to decrease the cost of living and open new fields for the employment of capital and labor.

Salisbury.

Population,	1,658
River frontage (miles),	6.1
Total valuation of assessed estates, April 1, 1913,	\$1,429,640

Answer to circular letter concerning public wharves: —

Salisbury would not probably care to go to the expense of building a public wharf.

Amesbury.

Population,	9,894
River frontage (miles),	4.5
Total valuation of assessed estates, April 1, 1913,	\$6,566,676
Number of establishments,	45
Automobiles, including bodies and parts.	
Bread and other baking products.	
Carriages and wagons and materials.	
Other industries.	
Capital invested,	\$3,008,226
Value of stock and materials used,	\$2,199,320
Amount of wages,	\$1,239,598
Wage earners employed,	2,007
Value of product,	\$4,542,008

Wharves, Docks, Landings and Terminal Facilities. — At Amesbury Ferry there are two coal wharves with steam equipment, handling together 4,000 to 5,000 tons of coal per year, from barges drawing not over 15 feet. At Amesbury, a short distance up the Powow River, which here enters the Merrimac from the north, is a coal yard and wharf with steam appliances, handling per year about 15,000 tons of coal from barges of the class running between Newburyport and Haverhill.

Answer to circular letter concerning public wharves: —

We feel as if we had no jurisdiction in regard to this matter, but would be willing to have an article inserted in the town warrant of March next, to see what action the town would take in the above matter.

Answers to questions in circular letter, concerning amount of coal used, etc.: —

To question 1: Tons coal delivered, 6,930; price per ton, \$8.60 to \$9.20; freight rate, \$3.05 all rail from mines to Amesbury.

To question 2: No information obtainable.

To question 3: That upwards of 200 tons of freight were received in the town.

To question 4: No information obtainable.

To question 5: No information obtainable.

To question 6: At least three firms now own and occupy wharves.

To question 7: Answered under question 6.

To question 8: The opinion expressed is that it should be 20 feet.

Extracts from statements made at public hearing held Nov. 25, 1912, by the Merrimac Valley Waterway Board, and from letters received: —

R. W. BRIGGS. We use the river practically for coal. We have had times we used it for other kinds of freight. A number of years ago we made successful use of it for shipping carriages, but owing to the trouble with the freight at that time it had to be abandoned. At present we are receiving 25,000 tons of coal a year.

Q. Does that all come by water? A. I should think two-thirds of it came by water.

Q. And does now? A. Yes. The coal men tell me there is a saving of \$1 a ton in the freight by water over rail.

Q. What is the principal industry in this place? A. I should think at present automobile bodies.

Q. Those are shipped all over the country? A. Yes.

Q. Where do you get the raw material, right here or is that shipped

here? A. I should say along tidewater we would get the coal, and Pennsylvania and Canada and Ohio for lumber.

Q. Would it be possible to have it come by water if the river was deepened and widened? A. I always understood that it would.

Q. When you ship your bodies away I suppose you ship them all over the country? A. Yes.

Q. And they go by rail? A. Yes, sir; I don't know how to express our interest in having a locking canal or deep waterway channel without a canal, unless we knew something about it.

Q. How large are the craft you use now to bring this coal up; how much do they draw? A. I think at high water they can draw 6 feet.

I would offer a suggestion for your consideration, that if there was to be a lock used instead of a deep waterway, if it was placed below the outlet of Powow River it would give us deep water all the time in the Powow River, and by locking that down to what I would call Deer Island, or the hat shop, that is a half mile below, that would give us high water in the Powow River. That would make it a navigable stream if you get the high water at all times.

Our shoe plants have used about 4,000 tons of coal, and I can't tell you what the wool consumption would be, but there is a large wool consumption. In addition to that we have modified industries connected with the automobile business, and at present we are doing quite a little shoe business in the town. There is a possibility, the shoe men tell me, of utilizing the river here under the proper conditions in connection with the shoe industry, to get the manufactured product right to the wharf in Boston, where they are shipped from, and that would be quite an assistance to us in water freights over railroad freights.

The town owns a small piece of land, I don't think it is over 200 feet, on the Powow River. We own perhaps 600 feet, but the land bordering on the Powow River is assessed very low.

I think we have nearly 3 miles of land bordering on the river, along the open river, along the Merrimac River, and I don't think the price of land along there would be prohibitive, that it could not be used for that purpose, if conditions warranted it, although no doubt it would be worth more than it is now.

Newbury.

Population,	1,482
River frontage (miles),	8
Total valuation of assessed estates, April 1, 1913,	\$1,510,218

West Newbury.

Population,	1,473
River frontage (miles),	6.5
Total valuation of assessed estates, April 1, 1913,	\$1,091,988

Merrimac.

Population,	2,202
River frontage (miles),	2.4
Total valuation of assessed estates, April 1, 1913,	\$1,284,443
Number of establishments,	7
Capital invested,	\$581,089
Value of stock and material used,	\$281,091
Amount of wages paid during year,	\$187,660
Wage earners employed,	280
Value of product,	\$643,956

Wharves, Landings, Docks and Terminal Facilities. — At Merrimacport, on the north bank of the Merrimac River, a short distance above Amesbury Ferry, is a coal wharf with steam equipment handling perhaps 4,000 tons of coal a year from the river barges.

Answer to circular letter concerning public wharves: —

The town is now having its landing defined by the county commissioners. We have three, two of which we have already located and surveyed, — so that we are able to offer for the public use two good landing places on the Merrimac River in Merrimac.

Groveland.

Population,	2,253
River frontage (miles),	2.2
Total valuation of assessed estates, April 1, 1913,	\$1,230,818

Wharves, Landings, Docks and Terminal Facilities. — On the south bank, 2 miles from Haverhill, at Groveland, is a coal wharf with steam equipment handling between 2,000 and 3,000 tons of coal per year. All of these are private wharves, without any rail connections, but with good highways for access, and are not open to all water carriers on equal terms, except to the extent necessarily involved in the actual condition that all the barge traffic is now conducted on the river by a single towing company, which supplies the barges themselves as well as the towboats that pull them.

Answer to circular letter concerning public wharves: —

That undoubtedly the town will do all that is possible to help the good work that you have commenced.

North Andover.

Population,	5,529
River frontage (miles),	2.7
Total valuation of assessed estates, April 1, 1913,	\$5,572,491
Number of establishments,	7
Capital invested,	\$1,864,100
Value of stock and materials used,	\$1,954,167
Amount of wages paid,	\$747,305
Wage earners employed,	1,310
Value of product,	\$3,305,698

Methuen.

Population,	11,448
River frontage (miles),	11.5'
Total valuation of assessed estates, April 1, 1913,	\$8,401,695
Number of establishments,	17
Capital invested,	\$3,392,704
Value of stock and materials used,	\$2,347,092
Amount of wages paid during the year,	\$639,063
Wage earners employed,	1,370
Value of product,	\$3,658,877

Answer to circular letter concerning public wharves: —

The matter would have to be brought before the voters at town meeting.

Andover.

Population,	7,301
River frontage (miles),	5.6
Total valuation of assessed estates, April 1, 1913,	\$8,086,475
Number of establishments,	9
Capital invested,	\$3,193,335
Value of stock and materials used,	\$2,174,339
Amount of wages paid during year,	\$667,594
Wage earners employed,	1,423
Value of product,	\$3,632,134

Dracut.

Population,	3,461
River frontage (miles),	3.1
Total valuation of assessed estates, April 1, 1913,	\$2,520,021

Tewksbury.

Population,	3,750
River frontage (miles),	1
Total valuation of assessed estates, April 1, 1913,	\$1,614,575

Chelmsford.

Population,	5,010
River frontage (miles),	2.4
Total valuation of assessed estates, April 1, 1913,	\$4,464,670
Number of establishments,	11
Capital invested,	\$4,806,873
Value of stock and materials used,	\$2,522,197
Amount of wages,	\$555,358
Wage earners employed,	1,214
Value of product,	\$3,353,454

Tyngsborough.

Population,	829
River frontage (miles),	10.1
Total valuation of assessed estates, April 1, 1913,	\$674,904

From material collected by Colonel Abbot, the quotations that follow are made.

Under date of Sept. 19, 1912, Mr. J. O. Ellison of Haverhill writes: —

I have been managing a steamer 170 feet long, 32 feet wide, on a draft of $10\frac{1}{2}$ feet, and have been coming to Haverhill for three years with very little trouble. . . .

I have had exceptional interest shown by the business men of Haverhill and all other places of any importance along the Merrimac River, and also including Gloucester, Lynn, Salem and Beverly, along the line of putting on boats for general freight to New York.

Under date of Sept. 7, 1912, Mr. Fred L. Atkinson of Newburyport writes: —

I am actively engaged now, and have been since 1884, in the whole-sale coal business. . . .

In about 1886 I saw moved 22,000 tons of coal in one season, from Newburyport to Lawrence and Lowell by lighter over Mitchells Falls by the Pentucket Navigation Company (so called, Hon. Benj. F. Butler and Hon. E. Moody Boynton), with an expenditure of a few thousand dollars at the falls.

Under date of Aug. 19, 1912, Mr. Levi L. H. Taylor of Haverhill writes: —

What we want is either a lock dam at Lions Mouth or river dredged so we can have 18 feet at low water. The barges of Standard Oil come to Haverhill, also tugs towing coal scows, but only on high water.

Under date of Sept. 17, 1912, Mr. Henry C. Long writes: —

I will say that the State of Massachusetts and the Merrimac valley stands ready to put up two millions of money to provide terminals, and to connect them with the channels, if the United States government will make a channel. I should say it, the channel, ought to be at least 300 feet wide and of sufficient depth for vessels drawing 20 feet, nothing less will be of any value. . . . There is perhaps not another waterway in the world of equal length upon the banks of which exists so much commerce, waiting for a channel to use it.

Under date of Sept. 18, 1912, Mr. Wm. J. Ward, proprietor of the Merrimac River Boat and Canoe Company, writes: —

The Merrimac is free of ice from the middle of March to the middle of December approximately, — a period of nine months. Freshets are few and of short duration. Seven feet is the greatest rise above the dam at Lawrence recorded (Essex Company records), — apparently an error. Average freshet rise, about $4\frac{1}{2}$ feet; duration of freshet, three to six days; usual number of freshets each year, one, shortly before or after April first; rarely have others in midsummer and fall; current at freshet time, 7 to 14 miles per hour, according to place, — usually 7 or less. Merrimac is navigable its entire length, from Lowell to the sea, for a boat drawing 6 feet of water when a freshet is on, as has been proven (1886, "Startled Fawn"). Gen. B. F. Butler of Lowell operated an experimental freight line from Newburyport to Lowell in early 80s or late 70s (reference, L. C. Prouty, 35 Marginal Street, Lowell). . . . From the Lawrence dam to a point east of Lowell called McMannons or Richardson Brook the depth is ample and free from obstructions, save a small submerged island on the north side 100 feet southwest of the head of Pine Island. . . . From Richardson Brook west to the foot of Hunts Falls in Lowell is a middle ground similar to that between Lawrence and Mitchells Falls. Through this a channel extends, partly obstructed by silt and sewage deposits. The distance of middle ground is about $1\frac{1}{2}$ miles. Thirty-five years ago a side-wheel steamboat navigated between Lawrence and the foot of Hunts Falls in Lowell. Boat drew 2 or 3 feet of water.

Under date of Sept. 18, 1912, the Haverhill Box Board Company writes: —

Our plant is located in the city of Haverhill on the southern bank of the Merrimac River. It is located very close to the river, where we can practically handle freight received by water as cheaply as if it came by rail. . . .

With the channel as proposed, this coal could be delivered to our plant in the original barges or schooners in which it is shipped at the same or a slight increase in the cost of delivering it to Newburyport. Any extra charge for delivering at Haverhill would be more than offset by the loss which we now have in transferring the coal at Newburyport, and the damage to it by the extra handling. We therefore figure we would have a saving of 57 cents per ton on our annual consumption of 27,000 tons, which would amount to \$15,390.

On our raw materials this smallest annual saving which we could hope for would be as follows: —

5,000 tons paper stock from New York, \$1 per ton,	. . . . .	\$5,000
15,000 tons paper stock from Boston, \$0.50 per ton,	. . . . .	7,500
2,000 tons wood pulp, \$3 per ton,	. . . . .	6,000
3,000 tons sulphite, \$1.50 per ton,	. . . . .	1,500 ¹
1,000 tons rosin, alum, twine, starch and miscellaneous supplies, \$1.50 per ton,	. . . . .	1,500
		<hr/>
		\$21,500

Out of a consumption of 48,000 tons of raw material we are only figuring on shipping one-half of it by water. . . . Regarding our finished product, estimating that we could ship one-third of our output by water, and more than that amount is always shipped to the following terminals: —

5,000 tons to New York at \$1.50 per ton,	. . . . .	\$5,000 ¹
10,000 tons to Boston at \$0.50 per ton,	. . . . .	5,000
		<hr/>
		\$10,000

. . . I might add that at the present time it requires from ten days to two weeks to deliver paper to New York. With the above transportation our goods could be landed in Boston the day following and in New York on the second day. You will realize the importance of these quick deliveries, as it often means the leverage by which business is secured. . . .

In recapitulating, the saving I have here given you would be as follows:—

<i>Estimated Saving.</i>		
On coal, . . . . .	. . . . .	\$15,390
On raw materials, . . . . .	. . . . .	21,500
On finished product, . . . . .	. . . . .	10,000 ¹
		<hr/>
		\$46,890

¹ Computation incorrect.

As this plant is only one of the great number on the Merrimac River, I feel assured if the other manufacturers interested will make up such a statement you will find that the United States government can afford to expend quite a handsome sum in deepening the Merrimac River from Lowell to the sea.

The mayor of Lawrence, Hon. Michael A. Scanlon, states: —

The State of Massachusetts, I think, is prepared next year to pass a bill appropriating \$1,000,000. The cities along the Merrimac valley are prepared to raise another million to go into this with, and we feel that in view of the fact that we are willing to help ourselves in this matter, the least the United States government can do would be to help along with as much at least as we are willing to give here.

MERRIMAC VALLEY WATERWAYS ASSOCIATION,
HAVERHILL, MASS., Dec. 19, 1912.

COLONEL ABBOT, *United States Engineering Corps, Boston, Mass.*

DEAR SIR: — If your report, after a careful examination of the Merrimac River, as authorized by the federal government, from Newburyport to Lowell, is favorable, it will mean more to the Merrimac valley than anything ever accomplished to relieve the present and future congestion in transportation.

If it should not be deemed expedient that a favorable report be given as far as Lawrence and Lowell at this time, I trust it will be deemed expedient to make such a favorable report from Newburyport to Haverhill, and especially to the point designated on the enclosed map.¹

The said point has been selected as the most appropriate place to terminate the channel, if the survey warrants it, because there are at that point about fifty acres of land which are available and can be bought for a reasonable price, with the Boston & Maine Railroad running along beside the same, and flanked by the river on the other side.

A bridge can be erected close to this point across the river, which will bring Lawrence within $4\frac{1}{2}$ miles of this city, whereas at present it is $7\frac{1}{2}$ miles to Lawrence. As is well known, the general tendency is for cities to extend westerly, and there is more available land at this point for Haverhill to spread than in any other direction.

I have a concern which stands ready to build a terminal at this point sufficient to handle all freight which would come up the river, and is willing to make a proviso that the same may be bought by the city at a price 10 per cent. over the cost of construction. This terminal being about $3\frac{1}{2}$ miles from Lawrence, would give, with auto trucks, better service to Lawrence than it has at the present time, with the railroad making a

¹ Not reproduced.

long run from this city to that city. Haverhill extends along the north bank of the river for 9 miles, 2 miles of which are covered with factories and retail stores, leaving 7 miles which are adapted for any and all kinds of industries; and extends along the south bank of the river for 5 miles, 3 of which are adapted for waterway and railroad shipping.

The saving on the shipping of coal alone would pay more than 4 per cent. on the construction bonds.

I believe that, if it seems unwise at this time to make improvements in the river from Haverhill to Lowell, the drawing enclosed will show you the course of a canal which seems feasible to me. This canal, starting at Concord, N. H., and touching the several towns shown on the plan, and terminating opposite the said point, would come within $\frac{1}{2}$ mile of Lowell and the same from Lawrence.

I think the dam should be placed below Chain bridge, as suggested by Captain Woodman, as it will save the improvements already made in Powow River and also make the said river as deep again. This will also save all difficulties arising through rise and fall of tides.

I would very much like to show you the location of the suggested end of the channel at Haverhill before you draw your report, and the location of the said terminal to be erected.

Very truly yours,

LESLIE K. MORSE,

President Merrimac Valley Waterways Association.

A committee was appointed in 1912 by the Governor of New Hampshire, at the suggestion of this Board, and conference has been held and inspection made of the upper portion of the river at Manchester and other points by representatives of the two States.

Among the statistical matter collected by the Board is the following relating to Nashua and Manchester, in New Hampshire: —

Statistics of the City of Manchester; N. H., prepared under the Direction of the Chamber of Commerce of Manchester; this Table is included, as the Creation of a Large Coal Terminal at Lawrence or Lowell might affect Coal Prices, due to Less Length of Railroad Haul, and Possibility of Electric Railway Coal Freighting.

Population (1910),	70,063
Population (1900),	56,987
Population, county (1911),	126,072
Total tax valuation (1909),	\$38,102,944
Total tax valuation (1911),	\$41,736,846
Total tax valuation (full), 1912,	\$68,452,145

Tax rate (1911),	\$2.04 per \$100
Tax rate (1912),	\$1.50 per \$100
Miles from Boston,	53
Trains to and from Boston, daily,	20
Tributary towns: —	
Bedford (population 1,110) (miles),	6
Goffstown (population 2,579) (miles),	8½
Hooksett (population 1,528) (miles),	7
Auburn (population 637) (miles),	1¼
Goffs Falls (miles),	1½
Has a tributary population of	250,000
Area of city (square miles),	33.9
Number of scholars in public schools,	5,337
Number of scholars in parochial schools,	3,395
Miles of water pipe laid,	117
Miles of streets,	206
Miles of sewers,	84
Miles of street railway,	40
Public parks,	13
Churches,	42
Volumes in public library,	65,000
Passenger trains north and south, daily,	60
Cotton and woolen mills,	36
Number of people employed,	15,000
Number of spindles,	670,000
Number of looms,	24,000
Pounds of cotton used yearly,	63,100,000
Yards of cloth (cotton) woven yearly,	235,873,750
Pounds of wool used yearly,	15,300,000
Yards of cloth (woolen) woven yearly,	21,000,000
Number of turbine wheels,	50
Annual pay roll mill operatives,	\$6,200,000
Savings banks' deposits,	\$27,039,313
Electric light companies,	1
Electric street lights running all night,	625
Bonded indebtedness of city,	\$1,645,000
Bonded indebtedness of city, exclusive of water bonds,	\$945,000
Sinking fund for city and water bonds,	\$716,885
Number of shoe factories,	10
Average yearly pay roll,	\$3,450,000
Average number pair of shoes yearly,	14,150,000
Number of operatives,	8,000
Cigar industry employs,	850
Pay roll annually over	\$6,000,000
Number of cigars made annually,	13,000,000
Net annual income on which city is run,	\$1,000,000

Number of men on police force,	53
Appropriation (1912),	\$85,980
Number of men of fire department,	181
Appropriation,	\$138,575
City is on six lines of railroads, is 41 miles from seacoast.	
Recreation resorts: Pine Island Park, Massabesic Lake, Uncanoonuc Mountain.	
Population of State (1910),	430,572

Statistics of Nashua and Manchester, N. H., for 1908, compiled under Governor Floyd and Board.

TOWN.	Number of Es- tablish- ments.	Capital invested.	Value of Stock used.	Amount Wages yearly.	People em- ployed.	Value of Product.
Nashua,	92	\$7,321,960	- ¹	\$3,452,026	7,451	\$17,176,439
Manchester,	157	25,208,766	- ¹	9,744,839	23,699	40,397,334

¹ No data given.

INVESTIGATIONS, SURVEYS AND EXAMINATIONS MADE BY THE COMMONWEALTH OF MASSACHUSETTS.

The provisions of chapter 96 of the Revised Laws relating to tidewaters, and defining the powers and duties of the Massachusetts Board of Harbor and Land Commissioners, are applicable to that part of the Merrimac River where the tide ebbs and flows, and that Board has exercised its jurisdiction over the same for years, with respect to encroachments, the building of bridges, wharves and other structures, and otherwise. The Commonwealth has not made any expenditures under the direction of that Board for dredging or otherwise improving the navigation of this river, but in 1902 ordered an investigation to be made by the Board of Harbor and Land Commissioners and a report submitted to the Legislature on the possibility and advisability of opening this river to navigation from Lowell to the sea. This report was printed in the annual report of that Board for 1902, and set forth in general terms the examinations, surveys and projects made by the federal government up to that time, the situation at Lawrence and Lowell, including the canals and locks and other matters. In speaking of the method of improving navigation between Haverhill and Lawrence, the opinion was expressed that the

best way would be the "construction of a dam and lock at Mitchells Lower Falls, the removal of bowlders and the dredging in shoal spots of the river between the upper falls and the lower lock in the canal at Lawrence, and the raising of bridges or the substituting of drawbridges over the canal from the lower locks to the dam of the Essex Company at Lawrence. . . . It is assumed that a dam at Mitchells Lower Falls 4 feet high, with a lock of about the same size as the lower lock of the canal at Lawrence, would be sufficient. That would allow navigation of the river from Haverhill to the lower locks at Lawrence for barges drawing about 4 feet of water."

There are three locks in the lower canal at Lawrence, 100 feet long and 20 feet wide, but over the sill of the lower lock there is only about 2.5 feet of water at ordinary low water in the river. After passing the lower locks into the canal there are fourteen bridges over the canal, connecting the city proper with the mill yards. Five of the bridges are railroad, two are highway and seven owned by the Essex Company and several mills, for the mill operatives, teaming and general use. The distance from the lower locks to the dam is about 1 mile. Under these bridges there is very little head room, — in some instances not over 2 feet. It would be impracticable for barges or lighters to use the canal without raising the bridges or constructing draws therein.

The fall of the river at Lawrence from the dam to the lower locks is about 28 feet.

In describing the river above the Lawrence dam, the Board say: —

From the dam at Lawrence to Hunts Falls, below Lowell, at the junction of the Merrimac and Concord rivers, about 9 miles, navigation is practicable after dredging away the shoals and bowlders near its upper end.

At Hunts Falls there are two sections, the upper and lower falls. From the basin above the falls, near the first lock on the Lowell canal to the basin below, is about 5,700 feet, and in that length of river there was a fall of about 11 feet in 1881. This has been reduced by the Locks and Canal Company, so that now the upper basin above the falls is only 7 or 8 feet higher than the basin below the falls.

The fall in the river in the 9 miles from Lawrence dam to Hunts Falls is only about 1 foot, and the channel is from 5 to 30 feet in depth, excepting one rocky shoal and some bowlders which could easily be removed. At Hunts Falls the current is very rapid, and the river bed is rocky and irregular, and only 2 or 3 feet in depth for some distance.

At Hunts Falls, in the opinion of the Board, it would be necessary to construct a dam and lock to aid navigation. It would not be practicable to cut away the falls sufficiently to allow barges to be drawn through a channel, because this would decrease the depth of water in the river above to less than the required navigable depth.

There are three locks in the canal between the Concord River and the pond above the Lowell dam. The length of the locks respectively is about 100 feet; the width of the lock gates is only 12 feet, and the locks would be available for craft drawing only 3 feet of water.

This canal from the lower locks at the Concord River junction to the dam above passes directly through the city. The fall from the dam to the lower lock is about 32 feet. Across this canal also are five highway bridges, three railroad bridges and two mill bridges. Just above the lower locks is an old highway bridge, and the head room between the average surface of the water in the canal and the truss of the bridge is only 18 inches. This is a much-travelled street in the city, fully occupied on both sides with mills, warehouses or stores. It would be very expensive to raise the bridge, on which buildings have been erected on either side of the travelled way, or to make a draw therein.

The concluding portions of this report are: —

The canals at Lawrence and Lowell are now very little used for the passage of boats. Many years ago rafts of logs and spars or masts were carried through the locks. There was also some other freight carried through the canals. Careful records of both canals have been kept of the passage of barges, rowboats, launches and canoes. The locks have been used for that purpose only a few times each for the last twenty-five years. No freight has passed through the canals for many years.

The locks of the Lawrence canal have been little used for the last twenty-five years. . . . The cost of the dam and lock at Mitchells Falls and at Hunts Falls, respectively, and the dredging of shoals and bowlders at several places in the river between Haverhill and Lowell, would be the smallest of the items of cost. A very large expense would be the raising of the bridges to make more head room, or providing the same with suitable draws; but larger than all would be the damages caused by the loss of power to the many mills on the banks of the two canals, and no approximate estimate of the cost can be given.

The dam at Mitchells Falls would decrease the flow and fall of water at the lower locks and mill raceways in the canal at Lawrence. This would probably not cause so large damage and loss of power as the dam and lock at Hunts Falls in Lowell. The building of a dam there would reduce the water power available for all the mills on the several canals in Lowell about 4 feet.

The cost of the work, including the building of two dams and locks, dredging shoals, removing bowlders, damages to water power and cost of street and bridge changes in Lawrence and Lowell, could only be accu-

rately determined after a long and expensive investigation by engineers and experts.

When completed, as above suggested, without substantially enlarging the locks (except at the lower lock in Lawrence), the river would be navigable to and through Lawrence by barges 20 feet wide, 100 feet long and drawing 4 feet of water; and to and through Lowell by barges 12 feet wide, 100 feet long and drawing 3 feet of water. Barges or craft of that size would not be safe for transporting freight even from Boston harbor. All freight for Lawrence or Lowell would require rehandling at Newburyport or Haverhill.

The amount of freight tonnage for the cities of Lawrence and Lowell should be considered in this connection. For the year ending June 30, 1902, all the freight carried into the two cities by the Boston & Maine Railroad was as follows:—

Carried into Lawrence:—

Tons of coal,	.	.	.	.	.	.	.	246,031
Tons of all other freight,	.	.	.	.	.	.	.	450,917.

Carried into Lowell:—

Tons of coal,	.	.	.	.	.	.	.	295,697
Tons of all other freight,	.	.	.	.	.	.	.	520,145

Coal would be more likely to seek water transportation than other freight. The mills for the most part have spur tracks to their boiler rooms. The necessary rehandling of coal in the lower river and the carting from canal to boiler room would have to be added to the water-borne freights in offsetting the greater all-rail coal rates; and the difference in cost of transportation would probably be small. The outgoing freight from the two cities would largely be by rail.

The work of opening the Merrimac River from Lowell to the sea would be feasible and practicable from the engineering point of view; but, considering the large cost and the damages involved, and the relatively small savings on freight which must be rehandled on the lower river and transported in such small barges, the Board reports that, in its opinion, it is not advisable for the State to undertake the large expense of opening the river to navigation from Lowell to the sea.

The United States engineers have for years made surveys and reports on this work, and the United States has expended large sums to improve the navigation of the Merrimac River. Apart from the large expense, it may be better to leave the work in sole charge of the United States.

Notwithstanding this adverse report, municipalities, Boards of Trade and other organizations, representatives in Congress, as well as public-spirited citizens in the Merrimac valley, have kept alive the movement for an improved waterway, bringing about in 1912 the legislation under which this Board is acting,

and co-operating with it, as well as independently, in collecting facts and data required by it and the engineer officer engaged in a preliminary examination of the river under authority of the river and harbor act of Congress.

BRIDGES, DAMS, LOCKS AND CANALS ON MERRIMAC RIVER.

Present Condition.

The river between Newburyport and Haverhill is crossed by eight bridges, six of which form a part of highways and two are Boston & Maine Railroad bridges. The clear height at mean low water varies from 19.5 feet, the lowest, to 41.5 feet, the highest. There are draws in six, varying from 38 feet, the smallest, to 76 feet, the largest, for the passage of water craft. The two upper bridges, namely, the Boston & Maine bridge at Haverhill, and the highway bridge at Haverhill, known as County bridge, have no draws therein, the clear height at mean low water being 41.5 feet at the railroad bridge and 32.5 feet at the highway bridge.

Between the County bridge at Haverhill and the Lawrence dam there are the following bridges, — Union Street, Boston & Lowell Railroad bridge, Boston & Maine Railroad bridge, Broadway bridge.

Between the Lawrence dam and Hunts Falls there are no bridges across the river.

Between Hunts Falls and the Pawtucket Dam at Lowell.

NAME OF BRIDGE ACROSS MERRIMAC RIVER.	Type of Bridge.	Used for what Purpose.	Approximate Grade under Side of Truss above Locks and Canals Datum.	ELEVATION OF WATER (FEET).	
				Ordinary Height.	In Extreme Freshet (March 3, 1896).
Centralville, . . .	Steel truss, .	Highway and street cars.	67.7	45.0	63.2
Aiken Street, . . .	Steel truss, .	Highway, .	73.3	46.0	65.0
Moody Street, . . .	Deck steel truss.	Highway and street cars.	82.6	55.0	81.4
School Street or Paw- tucket. .	Steel truss, .	Highway and street cars.	97.1	65.0	90.7

Between the Pawtucket Dam at Lowell and the State Line.

Vesper Country Club, .	Suspension, .	Private foot bridge.	108.5	87.0 ¹	100.7
Tyngsborough, . . .	Steel truss, .	Highway, .	104.6	87.0 ¹	102.8

¹ Top of flashboards.

The construction of a central bridge, with suitable approaches, over this river, at a point between the present Broadway bridge and Union Street bridge, has been authorized and provided for by the Legislature in chapter 513 of the Acts of 1906, chapter 486 of the Acts of 1907, and chapter 640 of the Acts of 1913, and it is understood that plans are now being prepared under the direction of a special bridge commission.

In order to make use of an improved river channel, as indicated in this report and shown on the accompanying maps and plans, any plan adopted by this bridge commission should provide for a structure with a draw therein having an opening of not less than 50 feet in width.

By license granted by the Board of Harbor and Land Commissioners July 24, 1912, the county commissioners of Essex County were authorized to extend the center pier of the bridge between Haverhill and West Newbury, known as Rocks bridge, by building a timber crib at the northerly end of said pier and to jacket with wood the westerly stone pier of said bridge, to carry out certain requirements of the War Department.

By chapter 613 of the Acts of 1913 the county commissioners of Essex County were authorized to reconstruct that part of this bridge which lies east of the draw. Plans of the proposed work were approved by the Board of Harbor and Land Commissioners Sept. 3, 1913, it being provided in the license granted that the foundations of the pier nearest the channel and draw be at such depth as to allow future deepening of the river channel to 18 feet at mean low water without impairing the stability and safety of the bridge.

By chapter 826 of the Acts of 1913 the county commissioners of Essex County were authorized to repair or reconstruct that part of the bridge between Haverhill and Groveland, known as Groveland bridge, which lies east of the draw. Plans of the proposed work were approved by the Board of Harbor and Land Commissioners Sept. 3, 1913.

No changes in the drawways of these bridges were required by these licenses.

DAMS AND WATER POWER.¹

The first step toward the construction of any hydraulic works on the Merrimac River was taken June 27, 1792, on which date a corporation, known as the "Proprietors of the Locks and Canals on Merrimac River," was chartered for the purpose of improving the navigation of the river and rendering it navigable by boats from tidewater to the New Hampshire line.

The dam at Lawrence, built of stone and near the foot of what were known as Bodwell's Falls, the first structure of that kind reached in passing up the Merrimac River from Haverhill, was completed in 1848, and is owned by the Essex Company, incorporated in 1845.

This dam creates a pool and deadens the current as far as the foot of Hunts Falls, and gives a pond area of about 29,000,000 square feet.

There is a canal on each side of the river; the one on the north side being about 5,330 feet long, 100 feet wide at the upper end and 60 feet at the lower end. At the head of this canal there is a lock and at the foot three locks descending into the river.

The south canal was built in 1866, and carried for a distance of 2,000 feet with a rectangular section 60 feet wide and 10 feet deep.

The dam at Lowell, known as the Pawtucket dam, is the next structure of that character existing above the Lawrence dam at Lawrence. The canal known as the Pawtucket canal was built before 1800, having been opened in 1796.

In 1822 the Merrimac Manufacturing Company was incorporated and this company in that year enlarged the Pawtucket canal.

It appears that in 1821 there was a wing dam at the head of the falls, together with a saw and grist mill. This dam extended to what is known as Great Rock, and its top was several feet below the top of the present dam. In 1825 there was a temporary dam across the river, and in 1826 the Merrimac Manufacturing Company appeared to have made a be-

¹ In part from water power of United States; census of 1880.

ginning on a new dam, but in that year this company transferred its real estate to the Proprietors of the Locks and Canals, which completed the dam in 1830 to 2 feet below its present height. It was raised 2 feet in 1833 by putting on two courses of granite stone.

In 1847 that part of the dam between Great Rock and the gate house was rebuilt in its present position, to conform to the entrance to the northern canal, which was built during that and the previous year (1846).

In 1869 the Directors considered the propriety of rebuilding the remainder of the dam from Great Rock to the north side of the river, but it was not decided to commence the work until February, 1875. A new dam was built on nearly the same site as the old one. This dam deadens the current in the ordinary state of the river for about 18 miles, forming, in low water, a reservoir of about 1,120 acres. The dam is situated at the head of what are known as Pawtucket Falls, and for a distance of about one-half mile below the gate house the bed of the stream is solid rock, and the banks high and rocky.

Two canals lead the water from above the dam, the original Pawtucket canal, enlarged in 1822 and 1823, and the northern canal, both on the south side of the river. Various other canals intersect these two.

The fall at Lowell, at ordinary low water, is about 40 feet, of which about 3 feet is lost in consequence of the descent in the canals, leaving a net fall of about 37 feet.

The Lowell mill pond extends to the foot of Cromwells Falls, $4\frac{1}{4}$ miles above Nashua and $17\frac{3}{4}$ miles above Pawtucket dam. From this point up to Manchester, N. H., a distance of about 13 miles, the river rises about 33 feet.

The water power derived from the river at Lowell is controlled and operated for ten different manufacturing corporations by the Proprietors of the Locks and Canals on Merrimac River. The turbine water wheels now established are capable of drawing from the pond above the dam through the canals 9,211 cubic feet per second and developing 29,911 horse power. Additional or larger wheels are occasionally put in. All power developed here is used in manufacturing upon adjacent mill sites.

At Lawrence the water of the river is controlled and operated and furnished to the several manufacturing corporations by the Essex Company. The turbine wheels now established are capable of drawing from the pond above the dam through the canals 9,906 cubic feet per second and developing 25,251 net horse powers.

A record of the craft passing through the Essex Company's north canal during the years 1908-12, inclusive, is as follows:¹ —

YEAR.	Launches passed.	Rowboats.	Canoes.	Sailboats.	Boats.	Scows.	People.	Craft carried by L. Locks.	Lumber Rafts.	Dories.	Various Craft.	CRAFT.		
												Up.	Down.	Total.
1908,	8	-	8	1	-	-	29	8	-	-	-	5	12	17
1909,	22	1	9	1	-	-	55	9	-	1	-	16	18	34
1910,	16	-	7	-	-	-	48	8	-	2	-	10	15	25
1911,	15	-	9	-	-	-	61	9	-	1	-	7	18	25
1912,	17	2	13	-	-	-	79	15	-	1	-	16	17	33

¹ Furnished by the Essex Company.

SURVEYS, MAPS AND PLANS BY THE MERRIMAC VALLEY WATERWAY BOARD, AND PROJECT FOR DEVELOPMENT.

For the purpose of ascertaining the feasibility, merits and probable cost of a canal on the south side of Merrimac River, from a point on the river bank just below Ward Hill to the pool above the Lawrence dam, surveys were made by Mr. George W. Wood of Malden, Mass., civil engineer, who was engaged to make surveys, examinations and estimates of cost in connection with this inquiry. This survey covered two locations for the canal, one entirely on the south side of the Boston & Maine Railroad, connecting with the river just below Ward Hill cut; the other beginning at the same river point, below Ward Hill, and following the Ward Hill railroad cut, the south bank of the Merrimac River, crossing the Boston & Maine Railroad near the mouth of the Shawsheen River, thence to the same point above the Lawrence dam.

The valuation of the property which it would be necessary to purchase or take on both of these locations was obtained, and

the physical difficulties and other matters connected with the construction of such a canal as would serve the purpose of allowing the passage of vessels from the lower river to a point above this dam were carefully considered.

The conclusion reached by the Board was that, owing to the land damages, which would amount to a large sum, the cost of necessary bridges at various streets in North Andover and South Lawrence, the relaying of sewers, water mains and car tracks, the large amount of water which would be required in the canal, and particularly as such a canal would not, in the judgment of this Board, best serve the business interests of Lawrence, a channel dredged in the river and canals constructed across Ward Hill and at the Lawrence dam would be a better solution of the problem.

The project developed on these lines is described later, and shown on the maps and plans annexed to this report.

Access to and use of surveys and maps of sections of the river made by the Essex Company and the Proprietors of Locks and Canals were courteously allowed.

The length of river between the Lawrence dam and the upper limit of this survey at Hunts Falls is about 8.8 miles, and between the Lawrence dam and the lower limit about 6.5 miles.

The stretch of river from the upper limit of the Board's survey to the boundary line between Massachusetts and New Hampshire is about $11\frac{1}{2}$ miles, and the Board's inquiry with respect thereto has necessarily been confined to an inspection and the collection of such data as will be valuable for future use in preparing a project for improvement of navigation as far as the State line, which, if carried into effect, would not only benefit those communities along the river banks in Massachusetts, but, if extended, would be of the greatest advantage to the cities of Nashua, Manchester and other points on the river front in New Hampshire.

Immediately after this Board's acceptance of the condition previously referred to, that the State should make a survey of the Merrimac River and prepare a project, with estimate of cost for a channel having a depth of 18 feet and suitable width from Ward Hill to Lowell, the engineer was instructed to supplement the surveys already made by him by one between

the points indicated above; to direct and supervise the work of making borings necessary to determine the character of material which would probably be encountered in carrying out any project involving excavation and dredging, either wholly in the river or partly in the river and partly across a portion of the adjoining shore within this stretch of river; to prepare a map showing thereon the shore lines, topographical features, soundings and other details, also the location and width of the proposed river channel; and to prepare and submit a report and estimate of cost of the necessary dredging and excavation to provide a channel 200 feet wide and 18 feet deep from Ward Hill to Lowell.

Subsequently, Edward C. Sherman, civil engineer, of Boston, Mass., was employed to act as consulting engineer, and advise the Board on important engineering questions involved in this investigation, including a study of the existing conditions at the Lawrence dam, the building of locks, canals and dams, the rebuilding of existing structures, and to submit a report, with plans, estimates and suggestions, as to the necessary works, their probable effect, if any, upon the valuable water-power privileges at Lawrence and Lowell, the creation of additional water power in the river, together with any other matters pertinent to this investigation.

The project which the Merrimac Valley Waterway Board, has prepared, based on the surveys and examinations made by its engineers, and shown on the accompanying plans, provides for a navigable channel 18 feet deep by dredging in the Merrimac River, and by excavating and building a canal and locks at Ward Hill and a canal and locks at the Lawrence dam, which would permit the passage of vessels of 17 feet draft, which might proceed from the open sea up river in a channel 18 feet deep to a point opposite Ward Hill, below the Lawrence dam, thence to Hunts Falls at Lowell.

The total length of the improved water way would be about 15.3 miles, of which about 34,175 feet, or about 6.5 miles, would be below the Lawrence dam, and about 46,540 feet, or about 8.8 miles, above that dam.

The width as well as the depth of the river channel would be the same, namely, 200 feet and 18 feet, respectively, as that

recommended for an improved channel from the sea to a point opposite Ward Hill, and as described in the preliminary report of Col. Frederic V. Abbot previously quoted from.

The location of the canal to be constructed at Ward Hill is shown on the accompanying plans, and would extend from the river channel to be dredged up to Mitchells Falls, through the adjoining upland southerly of the river, a distance of about 4,255 feet, connecting again with the river at a point just above Kimball's Island. The width of this proposed canal would be 100 feet and the depth 18 feet. The dimensions of the proposed lock at the entrance to the canal down stream would be as follows: usable length, 350 feet; width, 45 feet; depth at gate sill, 18 feet. It is also proposed to provide an additional small lock for the use of small boats, leading from the westerly side of the turning basin in the Ward Hill canal to the river, for convenience and saving time.

The proposed canal and lock at the Lawrence dam would be located on the north side of the river, as shown on the accompanying plans, extending from a point below the dam to the pool above. The dimensions of this lock would be the same as the one proposed at the Ward Hill canal. As practically the entire normal flow of the river at Lawrence is used for power purposes, it is necessary to conserve for that purpose as much of the water as possible using only so much as may be absolutely required for lockage. It is proposed to divide the usable length of lock, 350 feet, into two chambers of about 110 feet and 240 feet, respectively, by means of intermediate gates, so that for any vessel a lock chamber of suitable length can be provided.

It is proposed to provide, in addition to the lock at Lawrence above described, a flight of two small locks, each about 50 feet long, 10 feet wide and 5 feet deep at low water, to be built adjacent to the large lock, for use by motor boats and other small craft, thus conserving the water supply and avoiding use of even the 110-foot chamber of the large lock.

The Board has carefully considered the subject of constructing a dam across the river at a point about 1,700 feet below the lower end of Kimball's Island, where the stream is about 400 feet wide, which would hold back the water and create a pool at a level which would not interfere with the flow

from the water wheels at Lawrence, thus reducing to a minimum the amount of excavation necessary for the channel.

The consulting engineer, in speaking of this proposed dam, says: —

The water cannot be permitted to back up to a higher elevation at Lawrence than it does now. At the same time, a reasonably tight dam with its crest at about elevation 4.5 should be available during times of low flow. . . . Owing to the very considerable rise of the river in time of flood, and to the presence of ice floes in the spring, the most satisfactory dam would be one of those which fold down on the bottom of the stream. . . . It is probable that a dam of the bear-trap type would best serve the purpose. . . . The proposed dam would consist of four bear-traps, each about 90 feet long, set between permanent masonry end abutments and three river piers. The piers would also provide supports for a combination highway and service bridge. . . . No design has been made for this dam, . . . but from sketches it has been roughly estimated to cost about \$310,000.

The necessary changes at the Lawrence dam, and work other than that already described above, would be substantially as follows: —

The total length of this dam, which is now, on its crest, 897 feet, would, after its proposed extension of about 175 feet at its south end, be reduced to about 875 feet by the construction of the proposed locks.

Above and near the Lawrence dam the excavation of a new entrance to the north power canal, and some changes at the south power canal, would be necessary.

It is proposed to excavate a channel way in the rock near and below the Lawrence dam to compensate in part for the restrictions of the river flow, and to further improve conditions by removing the present Broadway bridge and building a new double-deck structure on the site of the present Boston & Maine Railroad bridge, to serve for both highway and railroad.

It would be advantageous to have but one drawbridge over the lock at Lawrence, and by means of this new combination bridge the existing grade crossing and attendant dangerous conditions could be eliminated.

Other bridge changes would be of minor importance, comparatively, and would include the rebuilding of a portion of the present bridge, known as the Boston & Maine Railroad bridge, with a draw therein; also the rebuilding of Union Street bridge

with a draw, the passageway for water craft through each bridge to be not less than 50 feet wide.

The studies made by the consulting engineer have included one concerning a power plant which might be installed to develop power necessary for operating the locks at Ward Hill and Lawrence, to light the canals and the navigable river channels. It would be possible to pump back, over the Lawrence dam, an amount of water equal to that used in lockages to fully compensate the owners of the power rights, although further investigation and consideration of this subject may show that such a project would be inadvisable.

The engineers' reports, with estimates in detail, are printed in the appendix to the Board's report, and, with the maps and plans which have been prepared, are referred to as showing existing conditions and the projected improvements.

CONCLUSIONS AND RECOMMENDATIONS.

The recommendations and other matters contained in the report of Col. Frederic V. Abbot, which has been largely quoted in the report of this Board, and which provide for certain co-operation between the federal government, the State and the municipalities, are as follows: —

(1) *Newburyport as Upper Limit of Improvement for 17 Feet Draft.*

Assuming that a survey does not develop excessive rock areas, it would seem that this work would be so comparatively inexpensive that it can be reported as being worthy of being done by the United States, on condition that the State or municipality expend an equal sum in deepening the water between the channel and the wharves, and in providing a suitable public terminal open to all water carriers on equal terms, and connected with the railroad for interchange of water-borne and railroad-borne traffic.

(2) *Haverhill as Upper Limit of Improvement for 17 Feet Draft.*

No 17-foot dredged channel can probably be provided to Haverhill for less than \$1,600,000. . . . This plainly indicates that State or municipal co-operation must be a condition precedent to any work by the United States. . . .

It would then seem not unreasonable to assume that if the

State would guarantee maintenance of 17-foot draft to Haverhill at mean low water, and would contribute half the cost of original improvement, the United States might be justified in putting not to exceed \$800,000 into a 17-foot draft channel to Haverhill, if a survey should indicate that such a channel could be provided for \$1,600,000. . . .

The above is sufficient to show that without a full and complete survey and borings in the bed of the river from the mouth up, no fair report on the worthiness or unworthiness of a channel permitting vessels drawing 17 feet to reach Haverhill can be made.

(3) *Lawrence as Upper Limit of Improvement for 17 Feet Draft.*

The cost of carrying 17 feet navigation above Haverhill into the Lawrence pool cannot well be less, and is almost certainly greater, than the cost to Haverhill, the head of tidal navigation, if a 17-foot open channel be dredged to that point. It would seem that if 17 feet is to be given above Haverhill it should be done by the State, which now, under State charters, has full control of the water-power situation. Such a co-operation on the part of the State or municipalities would be equivalent in effect to contributing at least half the cost of making Lowell and Lawrence seaports, and would probably justify the United States in doing the work up to Haverhill, or perhaps to 1 mile above Haverhill, where the State canal south of Ward Hill would enter the river. . . .

With a pledge from the State to complete a 17-foot draft canal from the Merrimac River 1 mile above Haverhill into the pool above the Lawrence dam, and to operate the same free of tolls forever, it would then seem that the project of giving 17-foot draft to Haverhill at the cost of the United States might be a worthy one to be undertaken by the United States if a survey does not show too great cost. . . .

The possibilities seem so great that I report without hesitation that the river is worthy of the cost of such a survey up to Ward Hill about a mile above Haverhill. Above that point the surveys should be at State expense, as they are to do the work if the above recommendations are adopted by Congress.

CONCLUSIONS AND RECOMMENDATIONS OF THE MERRIMAC VALLEY WATERWAY BOARD.

A summary of the statistical information collected by this Board shows the following facts concerning the cities and towns along the Merrimac River in Massachusetts:—

Total population,	307,540
Total value of assessed estates, April 1, 1913,	\$262,710,204
Total number of establishments,	814
Total capital invested,	\$188,152,336

This represents about 53.1 per cent. of the capital invested in metropolitan Boston (including Boston and 39 other cities and towns), and about 14.4 per cent. of that invested in the whole State.

Total value of stock and material used,	\$116,870,360
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This represents about 36.5 per cent. of that of metropolitan Boston, and about 12.6 per cent. of that of the whole State.

Total amount of wages paid during the year,	\$42,004,459
Total number of wage earners employed during year,	85,069
Total value of product,	\$196,595,077

This represents about 36.1 per cent. of the total value of product of metropolitan Boston, and about 12.4 per cent. of that of the whole State.

The total coal consumption of these cities and towns exceeds 1,200,000 tons, only about 135,000 tons of which is now received by water. In the opinion of the manufacturers along the river an adequate water route for the receipt of this commodity would effect a saving in freight rates of from 50 cents to \$1 a ton, in addition to the saving in transportation charges on general merchandise, raw material and manufactured product.

The estimated total cost of carrying out the project prepared by the Merrimac Valley Waterway Board for improving the river from Ward Hill to Hunts Falls at Lowell is \$5,443,600, which is exclusive of land damages at Ward Hill; of the cost of removal of Broadway bridge at Lawrence and the construction of a new bridge at that point; and of the cost of making certain changes in existing bridges between Ward Hill and Broadway bridge. This total cost would be reduced about \$226,800 if the width of the proposed channel from the Lawrence dam to Hunts Falls was reduced from 200 feet to 100 feet. Assuming the estimated cost of carrying out the federal government project of improvement from the sea to Haverhill to be approximately \$1,600,000, as stated in the report of Colonel Abbot, the total cost of improving the Merrimac River from the sea to Lowell in the manner and to the extent shown would be approximately \$7,043,600.

The large expenditure necessary for improving the stretch of river between Ward Hill and the Lawrence dam is due to several factors, including the character of the material which would be encountered in the excavation, largely rock and ledge; a canal and locks at Ward Hill; a dam in the vicinity of Kimball's Island designed to form a pool above the same, and thus minimize the amount of expensive excavation and dredging required to obtain 18 feet of water without, however, injuriously affecting the existing valuable water-power privileges at Lawrence; and a canal and locks for passing the Lawrence dam, necessitating a curtailment of its present length, and its future extension to the south as a compensatory provision.

Above the Lawrence dam the survey does not disclose conditions which would call for the payment of a large amount per cubic yard for dredging to obtain a depth of 18 feet, but as the section of river to be improved is about 8.8 miles in length, the estimate of cost for a channel 200 feet wide amounts to approximately \$567,000, and for a channel 100 feet wide, approximately \$340,200.

As the results of the government survey now in progress, and the report and estimate of cost by the United States engineers based thereon, will not be a matter of public knowledge for some months, the Board in the following pages has set forth a suggested line of procedure which in its opinion should be carried out to show the Commonwealth's interest and willingness to aid in the projected improvement of this river.

The conclusions which have been reached by the Merrimac Valley Waterway Board, and the recommendations which it makes, — after full consideration of all phases of the questions involved in the investigations entrusted to it, and having in mind the large amount of business carried on, as well as the large saving in cost of transportation and the resultant benefit generally to this section of the Commonwealth as shown by the statistics and data herein set forth, — are: —

(a) That the Merrimac River should be improved and opened to navigation by providing a channel 18 feet deep at mean low water extending from the sea to Ward Hill, about 1 mile above Haverhill, and by providing a depth of 18 feet by means of a channel and by building canals and locks from Ward Hill to Hunts Falls at Lowell.

(b) That the federal government carry into effect a project providing for a channel 18 feet deep at mean low water, from the sea to Ward Hill, about 1 mile above Haverhill, and that the Commonwealth of Massachusetts co-operate with the federal government in carrying such project into effect, the basis, form and method of co-operation to be agreed upon after all facts and data have been obtained.

(c) That the Commonwealth of Massachusetts adopt and carry into effect the project prepared by the Merrimac Valley Waterway Board for the improvement of the Merrimac River from Ward Hill, about 1 mile above Haverhill, to Hunts Falls, at Lowell, substantially as outlined in this report, namely, by excavating a channel of adequate width and 18 feet deep in the river, and by building locks and canals to provide a depth of 18 feet, and that the federal government co-operate with the Commonwealth of Massachusetts in carrying such project into effect; and that the basis, form and method of co-operation in respect to the State's project be agreed upon at the same time as agreed upon in respect to the federal government's project for improvement of the river as far as Ward Hill.

(d) That work under projects for improvement of the Merrimac River from the sea to Hunts Falls at Lowell be carried on progressively, upstream and in such manner and at such times as will ensure the earliest possible completion of the projected channel as far as Lowell.

(e) That the Board of Harbor and Land Commissioners be given charge and jurisdiction over that part of the Merrimac River which is not tidal, substantially to the same extent as that Board's powers and duties now apply to tidewaters; that said Board be authorized to continue the investigation thus far made by the Merrimac Valley Waterway Board, particularly with reference to that part of the river from Hunts Falls to the State line, and the location of terminals, and to act in conjunction with the cities and towns in the Merrimac valley in the furtherance of such plans and projects for improving this river as it may deem worthy, and to have charge of and supervise all works of improvement.

(f) That the Legislature memorialize Congress to take early

and favorable action looking to the improvement of the Merrimac River, and its opening to navigation from the sea to Lowell, and urging that appropriations be made to carry out the necessary work in co-operation with the Commonwealth of Massachusetts.

(g) That an appropriation of \$1,000,000 be made by the Legislature for the purpose of improving the Merrimac River, and as evidence of agreement by the Commonwealth to a policy of co-operation with the federal government with respect thereto, the expenditure of this appropriation to be conditioned upon the passage by Congress of appropriations for the same purpose.

The foregoing report is respectfully submitted.

CHARLES C. PAINE, *Chairman*,
ANDREW B. SUTHERLAND,
LEWIS R. HOVEY,

Merrimac Valley Waterway Board.

JAN. 9, 1914.



APPENDIX.

APPENDIX.

REPORT OF GEORGE W. WOOD, ENGINEER.

Merrimac Valley Waterway Board, Room 131, State House, Boston, Mass.

GENTLEMEN: — I respectfully submit the following report on survey of the Merrimac River from Mitchells Lower Falls at Ward Hill to Hunts Falls, about 1 mile below Lowell, made for the purpose of obtaining the necessary data for determining the most desirable route for a navigable channel along that portion of the river, and an estimate of the cost of same.

In compliance with your instructions I conferred with Col. Frederic V. Abbot, Corps of Engineers, U. S. A., at his office, for the purpose of ascertaining his views, as he had been ordered by the Department at Washington to make a report on matters concerning the Merrimac River.

I was informed that in order to make a comprehensive report he desired to consider the merits of a canal leading from the pool above the Lawrence dam, overland, along the south side of the river and entering the river again just below Ward Hill, but that he lacked the necessary data, and no funds were available for making a survey. I was instructed by you to furnish the information desired, and accordingly a survey was made and plans covering this section were delivered to Colonel Abbot.

A study of this scheme was made for your information.

One line was considered lying entirely on the south side of the Boston & Maine Railroad, entering the river just below the Ward Hill "cut;" another starting from the same point above the dam and crossing the Boston & Maine Railroad near the mouth of the Shawsheen River, thence following along the right bank of the Merrimac River to the Ward Hill railroad cut, occupying the cut and entering the river just below; this line would necessitate the relocation of tracks in the cut.

A valuation of the property to be taken along both routes has been obtained and a study of the physical difficulties has been made.

On account of the large cost of land damages, the cost of building bridges at the various streets in South Lawrence and North Andover, relaying of sewers, water mains, electric car and steam car tracks, and on account of the large amount of water which would be required to operate the canal, and especially as such a route would not best serve the business interests of Lawrence, for which navigation of the Merrimac River was desired, it was thought best to abandon the overland project and confine all efforts to a study and an investigation of deepening the river bed from the Lawrence dam to Ward Hill; thence by a canal across Ward Hill to the river below.

Through the kindness of the Essex Company a large expense was saved by allowing free access to all their data pertaining to the matter, and accordingly assistants were employed in making tracings of their surveys and plans, and collecting all other information relative to the work in hand.

It was also necessary to do considerable field work in extending surveys outside of the data furnished by the Essex Company, and a thorough development of conditions at Ward Hill and the river below was made, also for several miles at and below Hunts Falls.

Colonel Abbot, in his report dated March 29, 1913, recommended that a channel be created 200 feet wide and 18 feet deep, suitably widened at the bends. After careful consideration by your Board, it was decided that these dimensions would meet all requirements, and plans and estimates have been made accordingly, *i.e.*, for a channel 200 feet wide and 18 feet deep from Hunts Falls to Ward Hill, and for a canal 100 feet wide across Ward Hill.

ABOVE LAWRENCE DAM.

The elevation at the crest of the dam is 34.12 feet above the Essex Company's reference plan, but during a large portion of the year flashboards raise the height of the pool to approximately 39 feet. On investigation it was found that the elevation of the water was seldom below elevation 36, consequently this elevation was considered to be a safe one on which to base an estimate for an 18-foot channel.

The distance from the dam to the upper end of a proposed turning basin at Hunts Falls is approximately 46,540 feet, or 8.8 miles; for nearly 3 miles of this distance very little dredging

will have to be done, the deepest cutting being at the upper end of the channel just below the falls, where more or less bowlders will be encountered and several areas of hard clay and gravel. Borings taken over the entire distance at intervals averaging 400 to 500 feet apart, or sufficiently close to show any change in the material, did not indicate that ledge rock would be encountered above an elevation of $+18$, but that a large portion of the material could be easily handled, so that a unit cost of 35 cents per cubic yard for the total excavation would be a reasonable price. It is estimated that 1,620,000 cubic yards of material will have to be removed, including turning basin at Hunts Falls, making the total cost \$567,000.

BELOW LAWRENCE DAM.

The distance from the lower end of the proposed lock at the dam to the entrance of the canal at Ward Hill is approximately 29,920 feet, or 5.7 miles.

Borings were taken over this stretch from 400 to 500 feet apart where the material continued to be of about the same character, but where any change was found they were made at more frequent intervals. At the upper end many bowlders were encountered, but the surrounding material was of such character that it would not be difficult to remove them. Farther down the river ledge rock was found at several places.

In order to be able to permanently maintain a depth of 18 feet of water in the channel, it was found that it would be necessary to place an obstruction, such as a movable dam, in the river at some point below the entrance of the proposed canal.

The dam could only be built to such a height as would not back up slack water at the lower locks to an elevation that would interfere with the power; this elevation was assumed to be $+3.7$; consequently, this fixed the depth to which the excavation must be carried in order to obtain an 18-foot channel, or, in other words, to elevation -14.3 . In addition to this, 1 foot has been allowed in the estimate for overdepth dredging.

This makes the total estimate of material from the lower end of the lock at the Lawrence dam to the entrance of the canal at Ward Hill to be 3,311,000 cubic yards, of which 40,000 cubic yards is estimated to be ledge excavation.

The borings indicated that a large proportion of the material would not be difficult to excavate, and that the cost would not exceed 45 cents per cubic yard.

3,271,000 cubic yards of earth at 45 cents,	. . . . .	\$1,471,950
40,000 cubic yards of rock at \$7,	. . . . .	280,000
		<hr/>
Making the total cost of this portion of the work,	. . . . .	\$1,751,950

WARD HILL CANAL.

It is proposed to leave the bed of the river near the head of Kimball's Island and follow the depression across Ward Hill point, entering the river again about 50 feet below the mouth of a brook. The center line of the proposed canal was laid out on the ground, and the necessary levels taken to determine the amount of excavation. On a plan submitted showing this route, there is a broken line indicating a slight change in direction, which will slightly decrease the amount of material to be removed.

The difference in elevation of the water surface at the upper end of the canal and that of the river at the entrance will necessitate the construction of a lock. Assuming the elevation of the water surface to be +3.7, as fixed by the dam in the river below Kimball's Island, and the elevation of mean low water at the entrance of the canal, where it is affected by the tide, to be — 4.8, the difference is 8.5 feet; but as only a few observations were made this difference may vary a foot or more; probably the difference is about 9 feet. In order to accurately determine mean low water at this point, a long series of observations should be made.

It is assumed that a canal 100 feet wide would meet all requirements and the estimate has been made on that basis. The distance across Ward Hill from river to river is 4,255 feet.

Borings, twenty-seven in number, have been made along and near the center line, at such intervals as would give a fairly good indication of the material. Ledge rock was found much nearer the surface than was anticipated, and nearly every boring struck rock at an elevation considerably above the bottom of the canal (—14.3). The average cut is approximately 28.5 feet, for a distance of 3,585 feet.

It is estimated that there are 384,000 cubic yards of rock excavation from the entrance at Kimball's Island to the lock, including 0.5 feet for overdepth, and the cost of removing the same would be \$1.20 per yard, making a total of \$460,800, — but on account of the large quantity, small risk of damage to property from blasting and easy disposal of material, this cost might be considerably reduced.

The amount of earth excavation covering the same distance and width, with side slopes of 2 on 1, not allowing for berms, is estimated to be 225,000 cubic yards. The larger part of this material, being of a sandy nature, could be handled easily, and it is estimated that the cost would be 25 cents per cubic yard, making a total of \$56,250, or a grand total, for canal, of \$517,050.

It will be necessary to do more or less paving where the edge does not extend above the water surface, to protect the slopes from the wash of passing boats, but this cost would probably not exceed \$2,000.

No estimate is given of excavation chargeable to the cost of locks and dam, as it has been included in the report of the consulting engineer, nor for that below the entrance of the lock at Ward Hill, as it is assumed that the United States government will provide a channel to that point.

On account of insufficient data it is not possible at the present time to make a reliable estimate of the cost of maintaining a depth of 18 feet in the channel.

Summary.

Distance from turning basin at Hunts Falls to Lawrence dam,	8.8 miles
Distance from dam to entrance of canal,	5.7 miles
Distance across Ward Hill Canal, river to river, . . . . .	.8 miles
<hr/>	
Total distance covered by work,	15.3 miles
Total number borings in river channel,	151
Total linear feet (successful borings) in river,	1,338
Total number borings across Ward Hill,	27
Total linear feet across Ward Hill,	315
Total linear feet of borings,	1,653

Excavation.

Above Lawrence dam: —

Channel and turning basin, 1,620,000 cubic yards at 35 cents, \$567,000

Below Lawrence dam: —

To entrance canal, earth, 3,271,000 cubic yards at 45 cents, \$1,471,950

To entrance canal, rock, 40,000 cubic yards at \$7, 280,000

1,751,950

Canal to lock, rock, 384,000 cubic yards at \$1.20,	\$460,800	
Canal to lock, earth, 225,000 cubic yards, at 25		
cents,	56,250	
	<hr/>	\$517,050
Paving slopes,		2,000
		<hr/>
		\$2,838,000
Engineering and contingencies, at 20 per cent.,		567,600
		<hr/>
Total,		\$3,405,600

Very respectfully,

GEO. W. WOOD,
Engineer.

DEC. 1, 1913.

REPORT OF EDWARD C. SHERMAN, CONSULTING ENGINEER.

Merrimac Valley Waterway Board, State House, Boston, Mass.

GENTLEMEN: — In accordance with your instructions I have made designs for the structures which would be required by a project to create a navigable channel in the Merrimac River from Lowell to tidewater near Ward Hill, and I have the honor to submit the following report on their purposes and probable costs.

GENERAL DESCRIPTION.

The project for which the structures described herein are designed is based on the assumption that the Merrimac River is to be made navigable from the sea to a point opposite Ward Hill, by providing a channel 18 feet deep at mean low water, under such plan of development as may be adopted by Congress and carried out by the War Department, and that the Commonwealth of Massachusetts is to prepare a project for a channel 18 feet deep from the point opposite Ward Hill to Lowell.

The proposed project would involve the construction of channels, locks and dams as follows: —

A channel would be dredged in the river from a point near Lowell to the dam at Lawrence to give a depth of 18 feet below the low-water level of the pool formed by the dam. At Lawrence a lock would be provided so that vessels could be passed by the dam into another channel not less than 18 feet deep, which would follow the river to a point just above Kimball's Island, where it would enter the proposed Ward Hill canal, a direct cut-off around Mitchells Falls to the channel, which, it is assumed, the United States will provide in the tidal section of the river.

Just below Kimball's Island a dam would be constructed to hold back the water and form a pool at the highest level possible without interfering with the flow from the water wheels at Lawrence, so as to reduce to a minimum the amount of excavation necessary for the channel.

The surface of this pool would always be several feet higher than the water surface in the river below Mitchells Falls. Consequently, a lock would be provided at the north end of the Ward Hill canal by which vessels would pass from one level to the other.

DIMENSIONS OF LOCKS.

As you have determined on 18 feet as the depth of the proposed navigable channel, the dimensions which I have adopted for the locks are fixed by the lengths and widths of such vessels as can navigate in a channel of that depth.

A careful study has been made of lists giving the dimensions of all vessels navigating the Atlantic coast, and it appears that, while the great majority of those which may be expected to use the river are from 140 to 190 feet long, and seldom more than 36 feet wide, there are nevertheless a very considerable and increasing number of coasting vessels of from 15 feet to 17.5 feet draft, which are about 250 feet long and up to about 43 feet wide.

In designing the locks additional allowance must be made for a towboat, since only a part of those vessels could navigate a comparatively narrow and crooked channel under their own power. The proper lock dimensions have consequently been determined to be as follows: —

	Feet
Usable length,	350
Width,	45
Depth at gate sill,	18

LOCK AND CHANGES IN DAM AND IN BRIDGES AT LAWRENCE.

Lock.

The entire difference between the water levels at Lawrence can best be overcome by one lock having a lift of about 35 feet at normal stages of the river. It would be located along the northerly bank of the river, as shown on sheet No. 1 of the plans accompanying this report.

The lock gates would be of the mitering, girder type, built of steel and having oak quoin and meeting posts. The upper gates would be 27 feet high and the intermediate and lower gates about 59 feet high. It is proposed to operate them by the method which has been adopted on the Panama Canal, that is, by means of a strut, one end of which is attached to the gate,

the other to the rim of a "bull-wheel" contained in a chamber in the lock wall and driven by an electric motor.

The filling culverts, one in each side wall, would run the entire length of the lock, filling and emptying the lock chamber being accomplished through ports near the lock floor. The flow in the culverts would be controlled by sluice-gates at the ends.

In order to avoid the danger of the lower lock-gates being rammed by a vessel, a heavy steel buffer beam is proposed. The presence of such a beam would require a vessel to stop some distance away from the gates, and if it were not stopped it is improbable that after destroying the buffer it would retain enough momentum to cause serious damage to the gates.

At the upper end of the lock the drawbridge will provide sufficient protection to the gates and the buffer beam can be omitted.

The possibility exists that, in spite of all precautions, an accident may happen by which one pair of gates would be destroyed while the others were open, permitting an unobstructed flow of water through the lock from the upper to the lower level. It is therefore proposed to make the drawbridge serve as an "emergency dam," the lower chords forming a horizontal truss which could support the upper ends of steel girders, which, lowered into the lock, would provide supports for wickets by which the flow could be checked without emptying the pool above the dam.

Practically the entire normal flow of the river is used for power purposes at Lawrence, so that no more water should be taken for lockages than becomes absolutely necessary. Consequently, although the total usable length of the lock would be 350 feet, it is proposed to divide that length into two chambers about 110 feet and 240 feet long by means of intermediate gates, so that, for any vessel, a lock chamber of suitable length may be provided and unnecessary waste of water avoided.

It is probable that a large part of the traffic will be vessels in tow, and that the towboats, after delivering them at their quays, will return downstream alone. A very considerable saving in water will result from the use of the 110-foot chamber by such craft.

The proposed Lawrence lock is shown in detail on sheet No. 2 of the plans accompanying this report.

Locks for Small Boats.

In addition to the commercial traffic, it is expected that a very large number of power boats and other small craft will use the improved river. As it is not desirable that even the 110-foot chamber of the large lock be used for such boats on account of the need of conserving the water supply, it is proposed to provide a flight of two small locks adjacent to the large one. These locks would be about 50 feet long, 10 feet wide and 5 feet deep at low water.

Water Levels at Lawrence.

The difference in the levels of the pools above and below the Lawrence dam will vary somewhat with the stage of the river and the storage conditions. The stone crest of the dam is at elevation 34.12, but the water is ordinarily held several feet higher by means of flashboards. The pool seldom, if ever, falls below elevation 36.0, nor has it ever been higher than elevation 44.0. The ordinary water level may be assumed to be at about elevation 39.0.

With these data the upper approach wall and the lock walls are fixed at elevation 45.0, so that they may never be overtopped by the water, and the upper sill is fixed at 18 feet below elevation 36.0, at elevation 18.0.

The proper elevation for the lower sill of the Lawrence lock is a problem which can be accurately determined only by more complete study than is justified by the purposes of this report.

It is not permissible that the pool level be higher than elevation 5.48 at Lawrence when the river discharge is less than about 4,000 cubic feet per second on account of interference with the existing power interests. Assuming that with that discharge the slope of the water surface to Ward Hill, which is now about 9 inches to the mile, will be about 9 inches in the whole distance after the channel is improved by dredging, the water surface at the lower end of the pool would be at about elevation 4.7.

If the discharge of 4,000 cubic feet per second were constant, a fixed masonry dam could perhaps be built at Kimball's Island to create a pool at this elevation, but as the water must not be backed up at Lawrence for any given discharge to a height greater than obtains at present, it is assumed that a movable dam, affording complete regulation of the flow, will be used.

It appears that when the mills at Lawrence shut down on

Saturday afternoon, and are closed over Sunday and sometimes over Monday when a holiday happens to come on that day, the whole discharge of the stream is frequently stored at the Lawrence dam, and the flow in the river channel is almost nothing. The leakage past the movable dam during such a period would be considerable, and would result in a lowering of the pool level by an amount which, until the dam is designed, is indeterminate.

Believing that the lowering might amount to about a foot before a new supply would begin to refill the pool, it has been assumed for the purposes of the designs that low water would be at elevation 3.7. Accordingly, the lower sill and the bottom of the lock are placed at elevation —14.3, to give the desired depth of 18 feet.

Changes at Lawrence Dam.

The Lawrence dam has a length on its crest of 897 feet. Although it is proposed to extend it about 175 feet at the south end, the total length would be reduced to about 875 feet by the construction of the locks. As this reduction in length would cause a great freshet, equal to that of 1896, to back up to an additional height of only about 3 inches, it is not considered impracticable.

The changes required above the dam would be slight, and would consist in excavating a new entrance to the north power canal and in such changes at the south power canal as the extensions of the dam render necessary.

The waterway below the dam is at present much obstructed by bridge piers. As the lock will further restrict the available area, it is proposed to excavate a channel in the rock of sufficient cross-section to compensate for this restriction, and further to improve the conditions by removing the Broadway bridge entirely, placing the highway on a new, double-deck structure on the site of the present Boston & Maine Railroad bridge, which would serve for both highway and railroad. This arrangement offers the great advantage of requiring but one drawbridge over the lock, and incidentally affords an excellent opportunity to eliminate the dangerous grade crossing which now exists near the north end of the bridge.

The changes which would be required in the other bridges are minor ones, and consist principally in the introduction of suitable bascule drawbridges.

Cost.

It is estimated that the cost of the work at Lawrence, exclusive of such excavation as is chargeable to ship channels in the river, of the removal of the Broadway bridge, of the proposed new combination bridge and the changes in the other bridges, will be about \$921,000.

The details of this estimate are given in an appendix to this report.

LOCKS AND POWER PLANT AT WARD HILL.

Ship Lock.

The proposed Ward Hill canal has been laid out to take advantage of the topography of the country through which it passes, and its direction at the north end is such that vessels must make a turn of nearly 90 degrees to enter the river channel. On account of the current in the river, this turn can best be made in a basin just above the lock, which, to avoid heavy excavation, is placed near and parallel to the river bank, as shown by the location on sheet No. 3 of the plans accompanying this report.

The details of the proposed lock, also shown on sheet No. 3, do not differ materially from those of the Lawrence lock previously described, except that the lift is made to fit the conditions that would be met. The intermediate gates are omitted since the quantity of water used for lockages would not be taken from a supply intended for power, and the time lost in filling a lock chamber longer than would always be necessary would be little on account of the low lift.

The upper sill is shown placed at elevation —14.30, which is the same as the lower sill at Lawrence, and the lower sill and floor of the lock are placed at elevation —22.80, which is 18 feet below mean low tide at this point. The lift wall would therefore be 8.5 feet high, but the actual lift for vessels will vary from that somewhat with the different stages of the river and of the tide.

Small Boat Lock.

Although the water supply would permit the use of the large lock by small boats, it is advisable to consider the advantages of a separate small lock for such craft on account of the saving in time. Such a lock is shown on the plan, leading from the westerly side of the turning basin to the river.

Power Plant.

The difference in level between the Ward Hill canal and the river near the proposed lock will ordinarily vary from about 3.5 feet to about 10 feet, depending on the stages of the river and the tide. It is probable that an average difference of about 7 feet will exist, and it may be found advantageous to install a plant to develop the power necessary for the operation of the locks at Ward Hill and at Lawrence, to light the canal and the navigable river channels, and possibly to pump back, over the dam at Lawrence, an amount of water equal to that used there in lockages so as to fully compensate the owners of the power rights.

It is possible that the uncertainty as to the quantity of water that would be available for power development on Sundays and holidays will render the project inadvisable.

Owing to lack of time this matter has not been thoroughly studied, but the possibility of power development should receive consideration in any actual improvement.

Cost.

It is estimated that the cost of the work at Ward Hill, including the excavation for the turning basin but exclusive of cost of site, will be about \$807,000. The details of this estimate are given in an appendix to this report.

DAM NEAR KIMBALL'S ISLAND.

As explained elsewhere in this report, it is important that the dam which forms the pool from Lawrence to Ward Hill be constructed so as to offer little obstruction to the flood flow of the stream, since, for any given discharge, the water cannot be permitted to back up to a higher elevation at Lawrence than it does now. At the same time a reasonably tight dam, with its crest at about elevation 4.5, should be available during times of low flow.

There are a number of types of movable dam which have been found successful in practice. The simplest type consists merely of stop-planks put in place and removed as required. Sliding gates were evolved from stop-planks, and these have been developed in various ways. One form, known as "Stoney" gates, has been built to close openings up to 45 feet wide.

Owing to the very considerable rise of the river in time of

flood, and to the presence of ice floes in the spring, the most satisfactory dam would be one of those which fold down on the bottom of the stream. It must be easily operated, free from complicated mechanism, and so strong and simple that ice cannot damage it, and should be capable of being lowered rapidly without chance of failure.

As the various forms of wicket dams which would satisfy these conditions are not easily made tight, and as the proposed pool would have to be maintained on days when the river discharge is practically nothing, it is probable that a dam of the bear-trap type would best serve the purpose.

It is therefore tentatively proposed to construct a dam across the river at a point about 1,700 feet below the lower end of Kimball's Island. The stream is about 400 feet wide at that point, and the proposed dam would consist of four bear-traps, each about 90 feet long, set between permanent masonry end abutments and three river piers. The piers would also provide supports for a combination highway and service bridge.

No design has been made for this dam as it would require much more time than has been available, but from sketches it has been roughly estimated to cost about \$310,000.

Conclusions.

The design and construction of the dam and locks, and the changes in existing structures at Lawrence, which would be necessary to the execution of your project for making the Merrimac River navigable from Lowell to tidewater near Ward Hill, would involve no unusual engineering problems, although there are many points which would require careful and thorough investigation.

It is believed that the results obtained are sufficiently accurate for the purpose of determining the practicability of the project.

Respectfully submitted,

EDWARD C. SHERMAN,

Consulting Engineer.

Nov. 19, 1913.

APPENDIX.

The details of the estimate of cost of the work at Lawrence are tabulated below: —

Excavation for canal approaches, 20,000 cubic yards at \$0.40, .	\$8,000
Excavation for extension of dam, 52,500 cubic yards at \$0.75, .	39,400
Dry excavation in rock, below dam, for channels, 20,300 cubic yards at \$2.50,	50,800
Removal of part Lawrence dam at lock, 1,140 cubic yards at \$1.75,	2,000
Dry excavation in rock, for chamber of lock, 23,400 cubic yards at \$2.50,	58,500
Approach walls at ends of lock: —	
Concrete, 6,400 cubic yards at \$7,	\$44,800
Riprap (from excavation), 1,480 cubic yards at \$0.65,	1,000
Spruce piles, 46,700 linear feet at \$0.22,	10,300
Yellow pine pile caps, 44 M. feet at \$100,	4,400
Spruce plank, 38 M. feet at \$90,	3,400
	<hr/>
	63,900
Wall at south end of Lawrence dam, 4,900 cubic yards at \$6.50,	31,900
Coffer dam, south end Lawrence dam, 340 linear feet at \$25,	8,500
Round piles, at \$0.25 per linear foot.	
Wales, at \$125 per M. feet.	
Sheet piling, at \$70 per M. feet.	
Steel rods, at \$0.10 per pound.	
Filling, at \$0.60 per cubic yard.	
Removing structures at \$6.67 per linear foot.	
Extension of Lawrence dam, 2,800 cubic yards at \$7,	19,600
Coffer dam around lock: —	
220 linear feet at \$43.50,	\$9,600
110 linear feet at \$25,	2,700
880 linear feet at \$56,	49,200
	<hr/>
	61,500
Round piles, at \$0.25 per linear foot.	
Wales, submerged, at \$120 per M. feet.	
Sheeting, at \$80 per M. feet.	
Steel rods, submerged, at \$0.10 per pound.	
Steel rods, at \$0.06 per pound.	
Filling, at \$0.60 per cubic yard.	
Gravel embankment, at \$0.50 per cubic yard.	
Framed lumber, at \$90 per M. feet.	
Removal at \$10 to \$14 per linear foot.	

Lock masonry: —

Concrete: —

1:2½:5, 38,460 cubic yards at \$7.50, . . .	\$288,500	
Cyclopean, 1,400 cubic yards at \$5, . . .	7,000	
Granolithic surfacing, 2,320 square yards at \$1.08,	2,500	
	<hr/>	\$298,000

Lock gates: —

Steel, 700,000 pounds at \$0.05½,	\$38,500	
Other materials,	6,500	
	<hr/>	45,000

Metal set in concrete: —

Cast iron, 260,000 pounds at \$0.04,	\$10,400	
Structural steel, 12,000 pounds at \$0.05,	600	
Reinforcing rods, 40,000 pounds at \$0.03½,	1,400	
	<hr/>	12,400

Buffer beam, 33,000 pounds at \$0.04½,	1,500	
Wicket girders and wickets, 130,000 pounds at \$0.05,	6,500	
Sluice-gates, motors, controllers, installations, at about \$50 per square foot of opening,	19,000	
Booms,	2,000	

Steel booms, floats, at \$0.04 per pound.

Chain at \$0.04 per pound.

Concrete anchors, at \$15 per cubic yard.

Timber booms, at \$0.15 per linear foot.

Anchors, at \$5 each.

Operating building,	8,000	
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12-inch pump, motor and piping for pumping water back above dam,	4,000	
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Lock-gate operating machines, 6 at \$3,200 each, say,	19,000	
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Electrical equipment: —

Wiring,	\$1,000	
Switchboard,	1,000	
	<hr/>	2,000

Small boat lock equipment: —

Lock-gates,	\$4,000	
Operating machines and motors,	2,000	
	<hr/>	6,000

\$767,500

Engineering and contingencies, 20 per cent.,	153,500	
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Total,	\$921,000	
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This estimate does not include excavation chargeable to channel in river, removal of Broadway bridge and changes in other bridges.

The details of the estimate of cost of the turning basin, locks and power plant at Ward Hill are tabulated below: —

(a) Turning basin: —

Dry earth excavation, 80,000 cubic yards at \$0.50, . . .	\$40,000
Dry rock excavation, 91,000 cubic yards at \$1.10, . . .	100,000

(b) Locks: —

Dry earth excavation, 77,000 cubic yards at \$0.50, . . .	38,500
Wet earth excavation, 16,000 cubic yards at \$0.75, . . .	12,000
Dry rock excavation, 23,000 cubic yards at \$1.10, . . .	25,000
Wet rock excavation, 6,000 cubic yards at \$2.50, . . .	15,000
Cofferdam, 730 linear feet at \$40,	29,200
Concrete masonry, 41,000 cubic yards at \$7.50, . . .	308,000
Granolithic surfacing, 2,000 square yards at \$1, . . .	2,000
Lock-gates,	20,000
Lock-gate operating machine,	12,800
Sluice-gates and machinery,	13,000
Metal to be set in concrete: —	
Cast iron, 130,000 pounds at \$0.04,	5,200
Steel, 10,000 pounds at \$0.05,	500
Buffer beams, 66,000 pounds at \$0.04½,	3,000
Operating building,	5,000
24-inch pump and motor,	5,000
Switchboard and wiring,	2,000
Equipment for small lock,	4,000

(c) Power plant: —

Flume excavation, 6,000 cubic yards at \$0.50, . . .	3,000
Concrete masonry, 2,500 cubic yards at \$7.50, . . .	18,800
Superstructure,	5,000
Equipment,	5,300

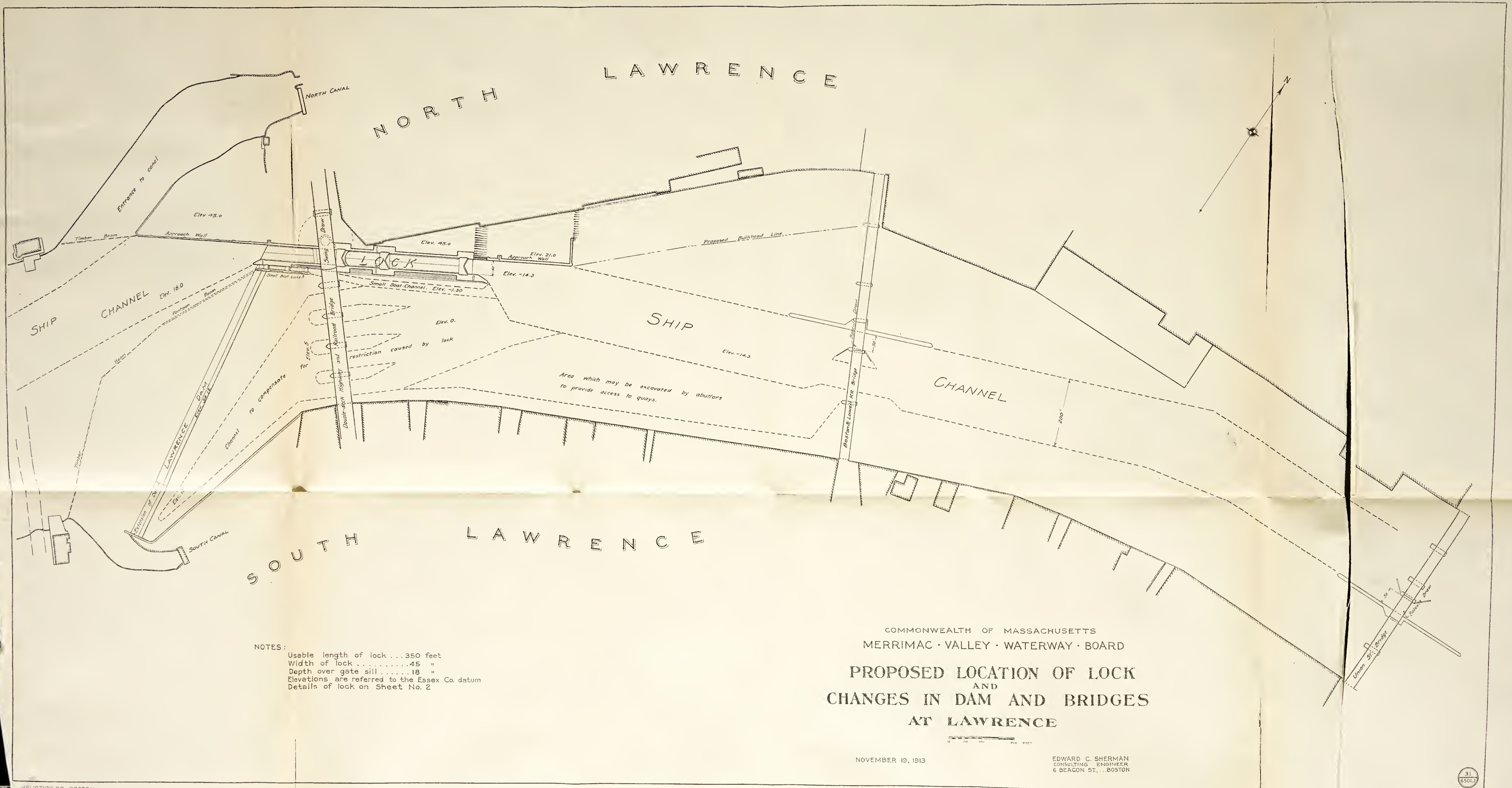
\$672,300

Add 20 per cent. for contingencies, 134,700

Total, \$807,000

И т а н





NOTES:
Usable length of lock . . . 350 feet
Width of lock 45 "
Depth over gate sill 18 "
Elevations are referred to the Essex Co. datum
Details of lock on Sheet No. 2

COMMONWEALTH OF MASSACHUSETTS
MERRIMAC · VALLEY · WATERWAY · BOARD

**PROPOSED LOCATION OF LOCK
AND
CHANGES IN DAM AND BRIDGES
AT LAWRENCE**

NOVEMBER 19, 1913

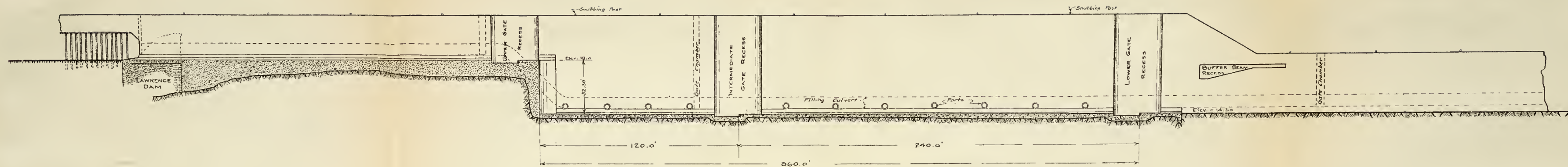
EDWARD C. SHERMAN
CONSULTING ENGINEER
6 BEACON ST., BOSTON



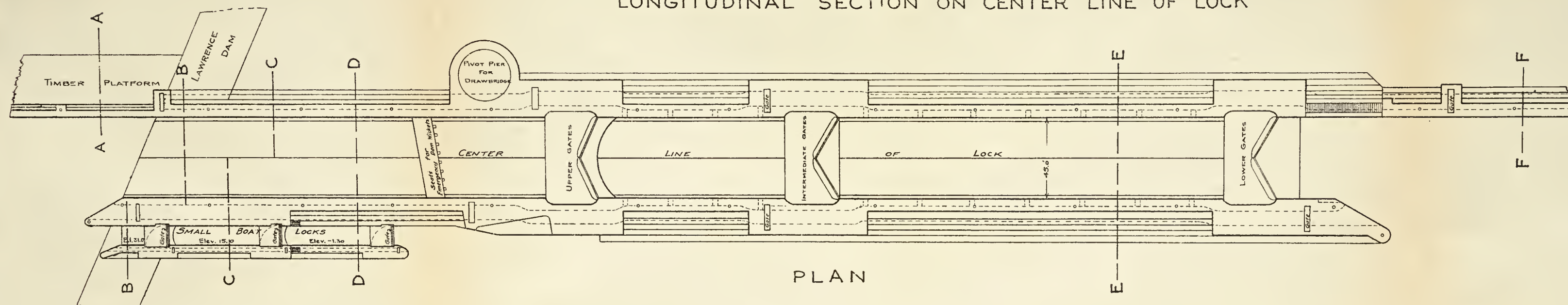
LONGITUDINAL SECTION



PLAN



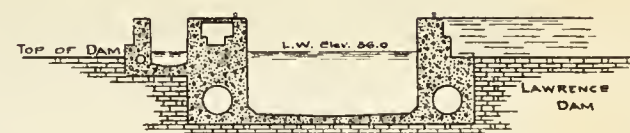
LONGITUDINAL SECTION ON CENTER LINE OF LOCK



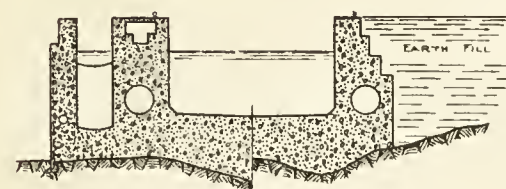
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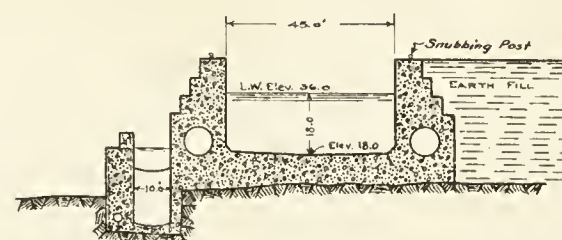
SECTION A-A



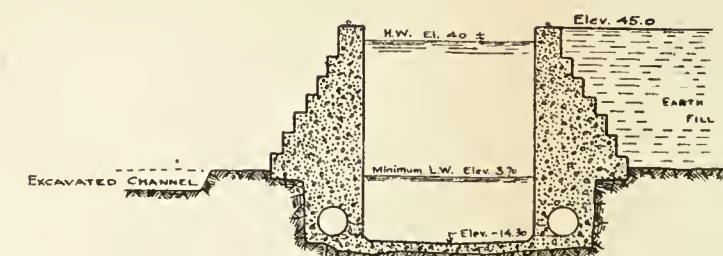
SECTION B-B



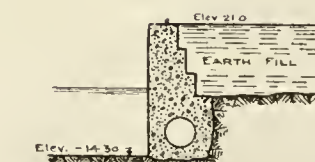
SECTION C-C



SECTION D-D



SECTION E-E



SECTION F-F

NOTE:
Elevations are referred to the Essex Co. datum.
For location see Sheet No. 1

COMMONWEALTH OF MASSACHUSETTS
MERRIMAC · VALLEY · WATERWAY BOARD
**PLAN AND SECTIONS
OF
PROPOSED LOCK AT LAWRENCE**

0 10 20 30 40 50 100 FEET

NOVEMBER 19, 1913

EDWARD C. SHERMAN
CONSULTING ENGINEER
6 BEACON ST., BOSTON

32
6501.2

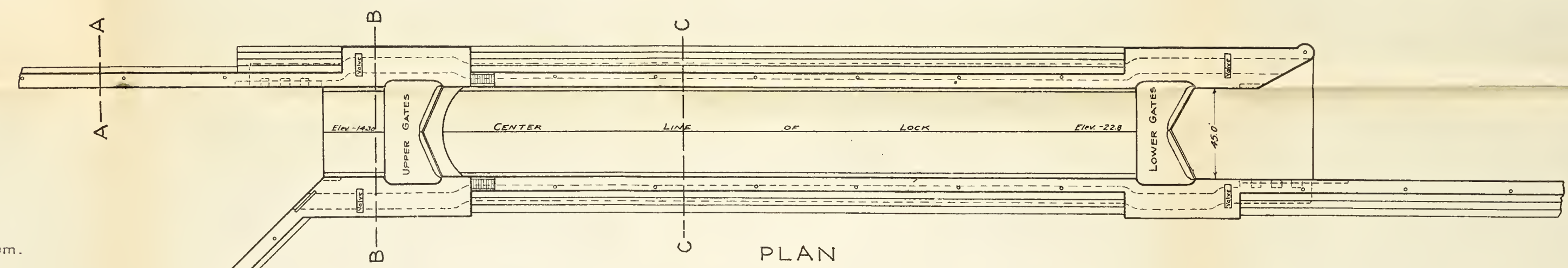
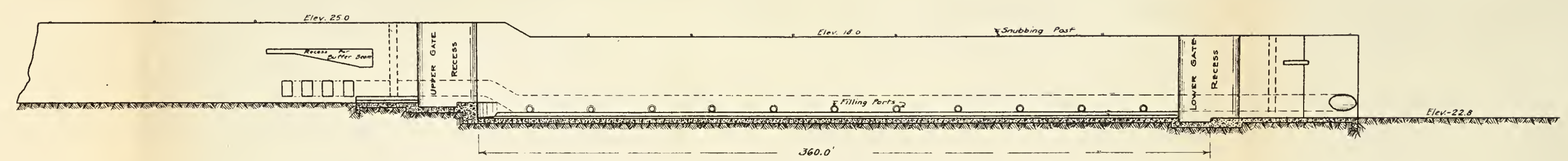
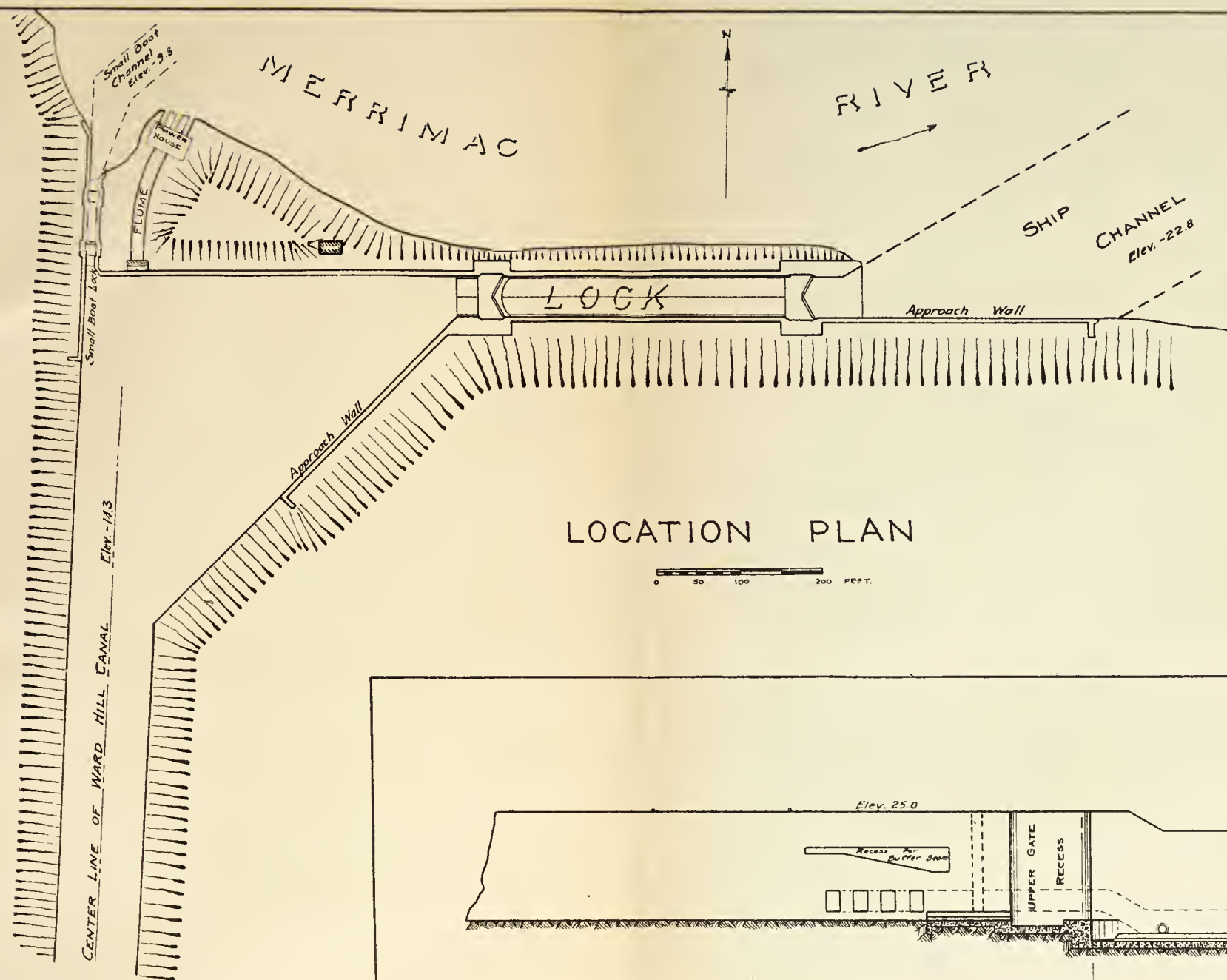
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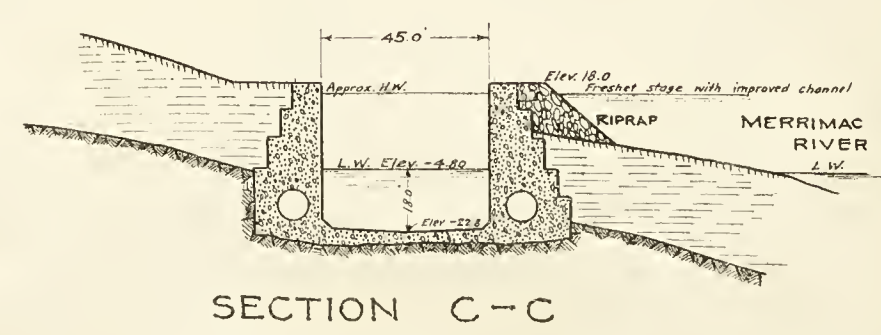
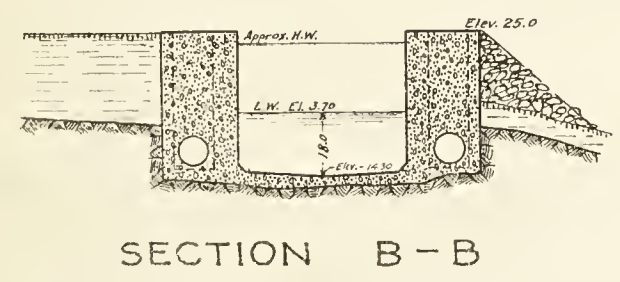
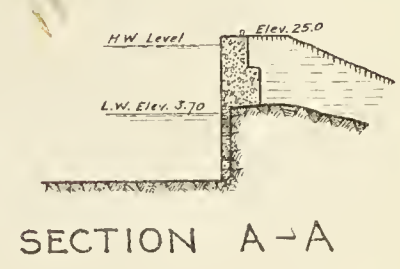
PA 17



CONTINUATION



NOTE:
 Usable length of lock 350 feet
 Width of lock 45 "
 Depth over gate sill 18 "
 Elevations are referred to the Essex Co. datum.

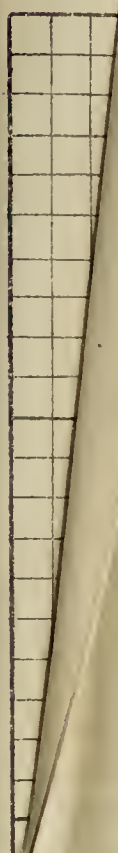


COMMONWEALTH OF MASSACHUSETTS
 MERRIMAC · VALLEY · WATERWAY · BOARD
WARD HILL LOCK



NOVEMBER 19, 1913

EDWARD C. SHERMAN
 CONSULTING ENGINEER
 6 BEACON ST., BOSTON



16
14
12
10
8
6
4
2
0
ESSEX CO. DATUM

Hunts Falls

High Water EL 400
Level of Pool EL 360

Bottom of Proposed Channel EL 100

PROFILE
ON CENTER LINE OF PROPOSED CHANNEL IN
MERRIMAC RIVER
WARD HILL TO HUNTS FALLS
PREPARED UNDER DIRECTION OF THE
MERRIMAC VALLEY WATERWAY BOARD
ESTABLISHED BY CHAP. 703 ACTS OF 1912
JAN. 1914

SCALES



CHARLES C. PAINE, Chairman
ANDREW B. SUTHERLAND
LEWIS R. HOVEY
MERRIMAC VALLEY
WATERWAY BOARD

GEORGE W. WOOD, Engineer
EDWARD F. SHERMAN, Consulting Engineer
R. G. JACOBS JR., Draftsman

NOTE

Datum used is Essex Co. base which is
34.2 ft. below crest of Lawrence Dam.
Crest of dam is 43.1 ft. above Mean Low
Water at Black Rocks, Newburyport.

Lawrence Dam
Bottom of Lawrence Dam EL 342
Proposed Level
EL 380
EL 373
Top of Flashboard
Dam (34.2)
EL 373
Bottom of Dam

High Water EL 227

Level of Pool EL 270

Bottom of Proposed Channel EL 143

Ward Hill

Proposed Level

High Water EL 152

Low Water EL 100

Bottom of Proposed Channel

ESSEX CO. DATUM

40
38
36
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-18
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-22
-24

THE RIVER

REACHES

BY WILLIAM BOARD

CHARTERED 1841

PRINTED BY J. H. B. & CO. 1841

NEW YORK

1841



MAP OF MERRIMAC RIVER

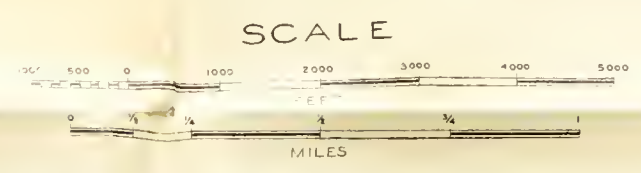
IN MASSACHUSETTS

PREPARED UNDER DIRECTION OF THE
MERRIMAC VALLEY WATERWAY BOARD

ESTABLISHED BY CHAPTER 708 ACTS OF 1912

COMPILED FROM SURVEYS BY THE MERRIMAC VALLEY WATERWAY BOARD, UNITED STATES GOVERNMENT,
BOARD OF HARBOR AND LAND COMMISSIONERS OF MASSACHUSETTS AND OTHER SOURCES

JANUARY 1914



CHARLES C. PAINE, Chairman
ANDREW B. SUTHERLAND
LEWIS P. HOVE

MERRIMAC VALLEY
WATERWAY BOARD

GEORGE W. WOOD, Engineer
EDWARD C. SHEPHERD, Consulting Engineer
W. W. MARSH, Draftsman

NOTE
Soundings are in feet and tenths and show depths below the
plane of Mean Low Water. Minus figures show elevations
above the plane of Mean Low Water. Soundings are
referred to Mean Low Water of the locality where taken.
Contour interval 20 feet. Datum Mean Sea Level.





MAP OF MERRIMAC RIVER

IN MASSACHUSETTS

PREPARED UNDER DIRECTION OF THE

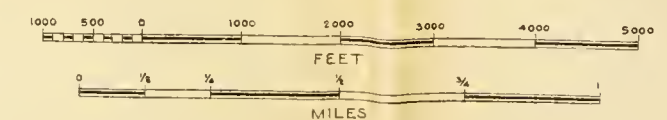
MERRIMAC VALLEY WATERWAY BOARD

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JANUARY 1914

SCALE



CHARLES C. PAINE, Chairman
ANDREW B. SUTHERLAND
LEWIS R. HOVEY

MERRIMAC VALLEY
WATERWAY BOARD

GEORGE W. WOOD, Engineer
EDWARD C. SHAW, Consulting Engineer
W. W. MARRIS, Surveyor

NOTE

Soundings are in feet and tenths and show depths below the plane of Mean Low Water. Minus figures show elevations above the plane of Mean Low Water. Soundings are referred to Mean Low Water of the locality where taken. Contour interval 20 feet. Datum Mean Sea Level.



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MAP OF MERRIMAC RIVER

IN MASSACHUSETTS

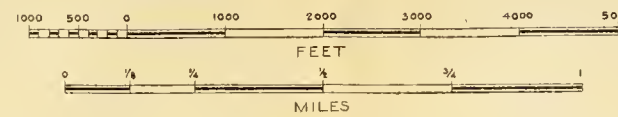
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CHARLES C. PAINE, Chairman
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LEWIS R. HOVEY

MERRIMAC VALLEY
WATERWAY BOARD

GEORGE W. WOOD, Engineer
EDWARD C. SHERMAN, Consulting Engineer
W. W. MARKS, Draftsman

NOTE

Figures are in feet and tenths and show elevations above the datum plane (Essex Co. which is 34.12 feet below the crest of the dam at Lawrence). Minus figures show depths below datum plane. Crest of dam 43 is feet above Mean Low Water Black Rocks datum, Newburyport. See report of Col. Edward Burr, Corps of Engineers U.S.A. November 30 1908 House Document No. 2, 61st Congress 1st Session page 9. Contour interval 20 feet Datum Mean Sea Level. To obtain the depth of water at any point in the river between the Lawrence dam and Hunts Falls subtract the elevations shown on map from 36 which is the assumed elevation of pool. To obtain the depth of water at any point in the river between the Lawrence dam and Mitchell's Falls, subtract elevations from 37 and add elevations to 37 which is the assumed elevation of pool.

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MAP OF MERRIMAC RIVER

IN MASSACHUSETTS

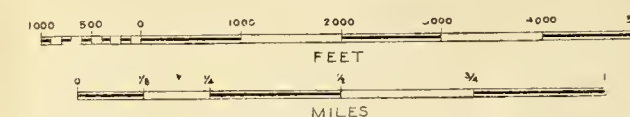
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JANUARY 1914

SCALE



CHARLES C. PAINE, Chairman,
ANDREW B. SUTHERLAND,
LEWIS R. HOVEY.

MERRIMAC VALLEY
WATERWAY BOARD

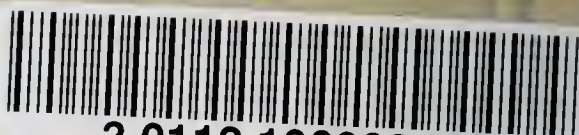
GEORGE W. WOOD, Engineer
EDWARD C. UERMAN, Consulting Engineer
W. W. MARRS, Calculator

NOTE FOR RIVER BELOW HUNTS FALLS

Figures are in feet and tenths and show elevations above the datum plane, which is 34.12 feet below the crest of the dam at Lawrence. Minus figures show depths below datum plane. Crest of dam 43 is feet above Mean Low Water Black Rocks datum Newburyport. See report of Col. Edward Burr Corps of Engineers USA Nov. 30, 1908. House document No. 2, 61st Congress 1st Session page 9. Contour interval 20 feet Datum Mean Sea Level.

NOTE FOR RIVER ABOVE PAWTUCKET DAM

Soundings are in feet and tenths and show depths below the horizontal plane passing through the top of the flashboards on the Pawtucket Dam at Lowell. 55.0 feet on the Locks & Canal Company's standard gauge. To obtain the depth of water at any point in the river between the Lawrence dam and Hunts Falls. Subtract the elevations shown on map from 55 which is the assumed elevation of pool.



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